Florence and Baghdad

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Hans Belting

Florence and Baghdad

Renaissance Art and Arab Science

Translated by Deborah Lucas Schneider

The Belknap Press of Harvard University Press
Cambridge, Massachusetts, and London, England
2011

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This book was originally published in German as *Florenz und Bagdad: Eine westöstliche Geschichte des Blicks,* copyright © Verlag C. H. Beck oHG, Munich 2008.

The translation of this work was funded by Geisteswissenschaften International–Translation Funding for Humanities and Social Sciences from Germany, a joint initiative of the Fritz Thyssen Foundation, the German Federal Foreign Office, the collecting society VG WORT, and the Börsenverein des Deutschen Buchhandels (German Publishers and Booksellers Association).

Library of Congress Cataloging-in-Publication Data

Belting, Hans.
[Florenz und Baghdad. English]
Florence and Baghdad : Renaissance art and Arab science / Hans Belting ; translated by Deborah Lucas Schneider.—1st English language ed.
p. cm.
Originally published: Florenz und Bagdad : eine westöstliche Geschichte des Blicks. Munchen : Verlag C. H. Beck oHG, 2008.
Includes bibliographical references and index.
ISBN 978-0-674-05004-4 (alk. paper)
1. Perspective—History. 2. Art, Renaissance—Islamic influences. 3. Aesthetics, Comparative. 4. Optics—Islamic countries—History. I. Title. II. Title: Renaissance art and Arabic science.
NC748.B4513 2011
701'.8209—dc22
2011003896

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Florence and Baghdad

Introduction

Describing a Culture: *Blickwechsel* (Shifting Focus / Exchanging Glances)

I.

This book and its topic grew out of research on the history of seeing that was originally limited to Western culture. The name "Florence" in the title stands for the Renaissance, since perspective—probably Western culture's most important pictorial idea—was invented there. The name "Baghdad" refers symbolically to Arab science, which had a profound impact on the Renaissance. In our context this means the historical Baghdad, the city that as the seat of the Abbasid caliphs long functioned as the center of the Arab world. The title of a recent book by George Saliba, professor of Islamic science at Columbia University, sums up my topic perfectly: *Islamic Science and the Making of the European Renaissance.*[1] Since this title expresses a hypothesis that runs counter to the general understanding of the Renaissance, readers are entitled to demand evidence. The same applies to the argument developed in what follows, that perspective art is based on a theory of Arab origin, a mathematical theory having to do with visual rays and the geometry of light.

One will search in vain for this argument in the scholarly research on perspective, but it makes sense to inquire about the history of a term that means something different in the history of science than it does in the history of art. The word "perspective" (*perspectiva* in Latin) was commonly used in the Middle Ages by scientists before it was introduced in the field of art during the Renaissance. Then it denoted a visual theory that was Arab in origin; only later, during the sixteenth century, did writers begin using it as a synonym for the term "optics," which occurs in scientific texts of classical antiquity. Nowadays it survives as a technical term solely in art history, where perspective refers to the first theory to

calculate images as the projections of a viewer. The earlier meaning has fallen into disuse except among historians of science. The mere fact that the two fields share a term would not mean much, however, if there were no inner connection between the theory of perception and the theory of art. The creators of perspective in art asserted that they were using perception as the standard for their works, but they based this claim on a definition of perception that they had not invented themselves. In fact they had found it in the legacy of an Arab mathematician that had reached the West. Lorenzo Ghiberti, one of the leading artists of Florence in the early Renaissance, still used the term "perspective" in a double sense; in his *Commentaries* he quoted long passages from the Italian translation of an Arabic treatise that set forth a scientific theory of vision.

Perspective will not be treated as a subject belonging solely to the domain of art, even though it has been an important topic of discussion in Western art. The true significance of the term becomes evident only when it is viewed in the larger context in which it originated. Perspective reveals its cultural dimension when it is understood in terms of pictures. Even within the domain of art, perspective does not stand alone but is closely linked to the modern conception of the portrait. From the very beginnings of secular theater, it also played a striking role as an element of stage sets. The notion of a "window" in the artistic and philosophical sense cannot be separated from the window as a model of perception. Along with the discovery of the horizon, a new conception of space also belongs to the context from which perspective emerged. The panorama is not complete, however, without mention of the modern subject or subjective consciousness that positions itself before a perspective image in the most literal sense—and by standing in such a location, discovers itself. The activity in which viewers engage there is one of *gazing*. This introduces a factor that played no role in the earlier visual theory on which perspective in art is based, and the scholarly literature on perspective still lacks a general investigation of the topic.

If perspective as Filippo Brunelleschi invented it and Leon Battista Alberti defined it in the early fifteenth century had been or remained a problem solely for artists, the topic could be handled within the confines of a single culture—as happens for the most part in any case. As a question of pictures, however, it brings another culture into play and raises the new questions discussed in this book. The phrase "two cultures" refers not just to the natural sciences and the humanities, the subject of so much discussion these days, even though there will have to be some mention of the relationship of science to philosophy and art, and thus eventually to the society in which scientific work is undertaken. Rather, I mean to

concentrate on a historical encounter with Arab culture that has had a lasting effect on the culture of the West.

This effect appeared with a time lag that requires a word of explanation. In the field of art history it is customary nowadays to emphasize the close parallels between Islamic and medieval European art, for example in the area of manuscript illumination, but my own study addresses a different question. The rationalism dominant in the era when Arab science reached its peak could not bear fruit in the West until the modern period, since it was based on scientific experiments liberated from every kind of theological baggage. During the epoch that we in the West call the Middle Ages, the subjects of mathematics and astronomy were popular in the Arab world, which had not yet come under the kind of dogmatic constraints so prevalent later. In Andalusia the coexistence or cohabitation of three cultures during the Middle Ages provided the impetus for translations of many Arabic texts, including Alhazen's treatise on optics to which Chapter 3 is devoted. Yet the explosively controversial implications of such texts, not all of which were based on Greek originals by any means, remained hidden for a long time; some did not become evident until the Renaissance, in the work of Copernicus, for example, or, in the case of the camera obscura, in the work of Kepler and Descartes.

The controversial implications of Arab visual theory also came to light only with the passage of time; this is the subject of Chapter 4. The debates over knowledge and perception in which scholastic theologians and men of science participated represent one instance of controversy; another is the introduction of the concept of mathematical space by Biagio Pelacani, who made innovative use of his source, Alhazen. Yet it is not until the essentially nonpictorial Arab theory of vision was transformed into a pictorial theory along Western lines that we arrive at the central concern of this study, which is to look at two different cultures with the issue of pictures as our theme. These two cultures differ markedly both in their practice with respect to pictures and in the way the member societies practice looking and seeing. This is obvious in the artistic use of perspective, for not only does no equivalent to perspective exist in the Middle East, but the existence of such an equivalent would be impossible, as will become apparent. The conception of pictures is entirely different there, and for a long time pictures that reproduced reality one-to-one, as it were, were banned. For the moment it may suffice to note that while Arab visual theory gave a predominant role to light, which is essentially aniconic, it relegated pictures to the realm of the mind exclusively. From this it follows that mental images could not be turned into something physical, could not be copied or reproduced in corporeal form.

When I delivered a lecture series on the cultural history of seeing at the Collège de France in the spring of 2003, it stood to reason that the topic of perspective would crop up, since at bottom it is nothing other than a cultural technique that has altered the visual culture of the modern period pervasively and to lasting effect. The quantum leap consisted in the way perspective introduced the gaze into the picture and thus, at the same time, the human subject doing the gazing. For precisely this reason Renaissance art was understood as a professional discipline based on a theory that had to be mastered. Artists saw themselves as practicing an applied science that had adopted a mathematical theory of visual perception. The previous history of this theory appears all the more contradictory when one reestablishes the scientific context in which it originated. For how could it happen that an Arab visual theory based on geometrical abstraction could be reconceived in the West so as to reverse its meaning completely and transform it into a theory for making pictures? How could it have come about that the same theory now made the human gaze the pivotal point of all perception and enabled artists to reproduce this gaze in paintings or, in the vocabulary of modern photography, "analog images"? The formulation of this question determined the path that the present study would follow, but also made it inevitable that I would have to cross the boundaries of my own area of specialization in order to relate two cultures. Viewing Western pictorial culture through the lens of a different culture remains a daring undertaking, but it may result in seeing both in a better light. My sole aim in taking up this twofold topic and discussing Renaissance and Arab cultures in one and the same context has been to achieve such a *Blickwechsel,* a word that can mean both a "shift of focus" and an "exchange of glances." But what does that really mean?

II.

Usually an exchange of glances takes place between two people or two speakers in a discussion. And in the course of history Arab and Western culture have also "exchanged glances," if such a broad metaphor is permissible, although these exchanges have been very different at different times and not always peaceful in nature. However, I would like to speak not about an exchange of glances between two cultures but about a shift of focus from one culture to the other. Their char-

acteristics become more striking when they are seen next to each other than when each is viewed separately and elucidated solely on its own terms, as is still normally the case for Western culture. With my chosen topic, such a shift of focus also has an obvious advantage because it makes unnecessary the constant use of words such as "influence" and "differences." The text is designed so that each chapter is devoted to one culture and ends with a *Blickwechsel* to the other, thus providing a natural break; the discussion changes direction without the need for a specific justification each time.

My intention was to place both cultures side by side and on the same level, so that neither would be overvalued or undervalued. This is the only way to limit or contain the inevitable Eurocentrism that long characterized Western views of other cultures. I must leave it to the reader to decide whether my attempt has been successful. The fact that it was by necessity a difficult undertaking could not be an excuse for giving up before I had even started, nor could the question of expertise be allowed to stand in the way, a question that plays a certain role in academia. There was a way out: I could have chosen to speak in terms of "influences," as I do, in fact, in certain passages. But this familiar term encourages a tendency to use two different yardsticks and to reinforce a colonial point of view, conceding a non-European culture's influence in one area but still relegating it to a lower level of importance overall. The shift of focus I have undertaken has no such intention behind it; rather, it strives to describe both cultures better, and it also avoids the awkward questions of who influenced whom and whether one culture was more open to outside influences than the other. Finally, a focus that places two cultures side by side offers access to the topic to two different groups of readers, namely to Westerners interested in the subject of linear perspective, who will come across information about Arab culture here, and to readers in the Middle East who want to become more familiar with Western perspective-based art, its cultural profile and its foundations.

Such a shift of focus makes something else evident as well: the two cultures that concern us here have a long shared history of encounters in which they inspired or challenged each other. For this reason it is worthwhile taking a look at them in the context of Mediterranean history, and easily possible to dispense with all the controversy that dominates the media today. Even in the area of religion, common ground exists under the heading "monotheism." One need only mention the word "Andalusia" to evoke a time in which Muslim, Jewish, and Christian cultures coexisted peacefully and fruitfully. Yet an overly simplistic accent on the positive raises its own dangers, namely a truncated and—therefore false—

view of history. For example, the cliché that Europeans owe their knowledge of classical Greek literature to translations from the Arabic does not do justice to the actual historical role played by Arab culture. The example of Ibn al-Haytham, or Alhazen, to whom Chapter 3 is devoted, reveals a very different story. The corrections he made to ancient optics were revolutionary, offering yet more proof that the contribution of classical Arab culture cannot be reduced to one of mere translation.

In a recent study George Saliba found new proof that even Copernicus had some familiarity with Arabic texts. The work of astronomers and philosophers like al-Kindi gave Arab science standing and authority in the West, as did the mathematicians who took up and discussed the "Arabic" numerals that had originated in Hindu culture.[2] In this context optical theory *('ilm al-manāzir)*—the science of "what appears" as distinguished from what is—was of the greatest significance.[3] It is represented by such famous figures as al-Fārābi (died ca. 950), but it was Alhazen's chief work—known by the title of the Latin translation, *Perspectiva*—that had the greatest resonance in the West, as Friedrich Risner's 1572 edition of the work proves. Alhazen, the inventor of the camera obscura, is considered to have pioneered the modern scientific method in his research, but his psychology and aesthetics reflect the worldview of his time and culture.

III.

Islam has become a hot topic in today's intense debates, but its very topicality carries the risk of distorting or even falsifying history. Many attempts to debate in a politically correct manner, to insist that one's own views are right or one's opponents' views are wrong, fail because they do not create the necessary space for other positions and impede a deeper view into our shared past. In "deep time"—the geological metaphor used by Siegfried Zielinski in his archeology of the media—dividing lines and commonalities that are forgotten or ignored in current debates become visible. In a climate of mutual suspicion it is often very difficult to make one's voice heard at all, yet it is pointless to join in the chorus of those who simply call for solidarity with the Islamic world and have turned the phrase "alliance of cultures" into a superficial slogan. We must go a step further if we are to identify the necessary distinctions that every culture needs in order to express it-

self and enter into the kind of dialogue in which facts and knowledge carry more weight than mere avowals of good intentions.

The philosopher Régis Debray recently categorized dialogues between cultures as a "contemporary myth."[4] While science and technology provide the foundation for a shared world, he sees culture as "a natural place of confrontation, since it is where identity is forged, and that in turn presumes a minimum of dissent." He cites Claude Lévi-Strauss, observing that "civilization contains within itself the coexistence of extremely diverse cultures and lives precisely from this coexistence." Debray considers it more necessary than ever today to open doors and tear down walls built of prejudice. Nevertheless, having the greatest possible amount in common should not become the issue, because only diversity can save us from misunderstandings.

My choice of topic will also be misunderstood. For many people in the West, an increasingly defensive attitude goes hand in hand with their fear of losing their own cultural identity (sometimes mistakenly believed to be universal) and becoming contaminated by other cultures. On the opposite side, people feel threatened by a comparison of cultures because they are afraid of losing in the comparison. They may also object to their culture or science being labeled as "Islamic"; after all, the West does not refer to its own culture and science as "Christian." And nowadays merely addressing the topic of pictures can quickly elicit charges of Eurocentrism, even if for Islamic cultures every effort is made to differentiate between epochs and geographical regions. A suspicion arises that Europeans want to deny the Middle East its right to images, a right to which every culture is entitled. To this one can reply that it is possible to define visual culture in terms other than the pictorial art that is taken as the standard in the West. The present study pursues this aim by seeking to find out what occupies the place of such art in Middle Eastern culture and how calligraphy and geometry have established an aesthetic standard based on mathematical models. In this context the question cannot be, "Why did linear perspective not exist in other cultures?" Rather we must ask about the particular conditions under which it originated in the West.

Distinctions of the kind made in this study nevertheless always presume that a larger whole exists in which they have their place. One can speak of differences only where there is also common ground. This requires an understanding of culture that is based on a premise not of inevitable conflict (as proposed by Samuel Huntington) but of shifting and flexible boundaries, the course of which becomes visible through the study of cultural history. Ilija Trojanow and Ranjit Hoskote's recent book *Kampfabsage* ("Renouncing Battle") offers a passionate argument

against Huntington's position.[5] In it they reject confrontation and profess their belief in a shared history in which Europe was permanently stamped by Arab culture and its ties to India. Only as a result of modern colonialism, it seems, did the rigid ideological barriers arise that divide the world today.

IV.

Mathematical perspective has been a popular topic in art history ever since Erwin Panofsky published his study on it in 1924.[6] The context in which it became a cultural technique of the modern period, however, has received scant attention until now. Panofsky called perspective a "symbolic form," and the impression arose that it was the only instance of such a form in the realm of art. To my knowledge, until now no one has posed the fundamental question of whether other "symbolic forms" exist—least of all in other cultures—as I do in the *Blickwechsel* at the end of each of the last two chapters. There I propose that the *muqarnas,* with its three-dimensional geometry, and the *mashrabiyya,* a form of window covered with latticework that screens out light, should be recognized as symbolic forms in Arab art. In Western culture, both the stage set (along with the culturally specific practice of staging plays in the modern period) and the modern panel painting (particularly the genre of the portrait) could be considered symbolic forms. Panel paintings were first introduced in other cultures in response to outside pressure under colonial rule.

Ernst Cassirer, who originated the term "symbolic form," defined it far more broadly, however, asserting that art in general was one such form, as were language, myth, and science. It may be that art has been a symbolic form in every culture and society, just as art was in the Renaissance precisely because of perspective, which distinguishes it from the earlier art of the Middle Ages. We can accept Cassirer's ideas if we understand perspective in art as a "cultural technique," since the latter term incorporates certain aspects of the symbolic form, although it refers more to practice. The decisive question, though, is what such a "form" or "technique" expressed and in what way it was "symbolic." Panofsky, once again following Cassirer, decided that it was "space," although he left the definition vague (see Chapter 1). In the present study the idea of *space* as the central concept is replaced by the idea of the *gaze.*

Norman Bryson prepared the way for this shift in accent more than fifty years after the appearance of Panofsky's essay.[7] Bryson distinguishes between two eras of perspective in which the kind of look directed at a work of art underwent a change. The Renaissance favored the protracted and quiet gaze, which is connected to an observer's body, while in the seventeenth century its place was taken by the rapid and fleeting glance. The emphasis on a brief glance tended to efface the presence of an actual physical body performing the act of viewing. When a glance loses all connection to a real observer, the "gaze" represented by a picture becomes an abstraction. This shift was a turning point for perspective as a cultural technique and also a turning point for its symbolism (Chapter 6). Whereas Bryson uses a comparison with East Asian art to describe the "deixis" of European art—that is, the way it shows us the world—in this study I use a *Blickwechsel,* a shift of focus to Arab art to perform the same function.

In the Western use of perspective in art, according to Bryson, the picture is linked to an observer; the picture takes that person's gaze as a yardstick and turns it back on him or her. The (observing) subject takes up a position before the painting, embodying both the painter and the viewer, so to speak, while the space that the gaze normally traverses is contracted to a single geometrical point. Here, Bryson argues, the viewer encounters the *punctum* or point, a term introduced by Roland Barthes. The gaze does not actually involve a single point, however, since it originates in a body with two eyes. For just this reason the Renaissance strove to resolve the conflict between the abstract *eye point* and the real body by devising the *vanishing point,* which stabilizes the gaze in the eye point. It is the vanishing point that represents the observer in the picture by assigning a symbolic location to him or her. In the vanishing point the visual rays come together at the horizon, just as they do on the other side, in front of the picture, in the eye point. In the geometry of perspective art this point lies just in front of the viewer's eyes.

One of Bryson's readers, the mathematician Brian Rotman, took up his arguments four years later, in 1987, and expanded them.[8] Rotman makes a surprising suggestion, namely that the number zero should be seen as having a link to the vanishing point and vice versa. He regards the introduction of zero to Arabic numerals and the invention of the vanishing point as parallel occurrences. Zero and the vanishing point both signify two different things. Just as zero is in one sense simply a number like all the others, so too the vanishing point is just one sign among all the other signs in a painting (figures, objects, and so on). At the same time, however, this point represents a sign of a completely different kind; it is of a different order, a sign that alters the meaning of all the other signs. Rotman calls

it a "meta-sign," because the presence of such a sign makes it possible to organize an infinite number of pictures, just as infinitely many numbers can be derived from zero.[9] The vanishing point is indispensable for perspective art, no matter what subject a given painting depicts, despite the fact that—or because—it is an abstraction among real motifs.

Rotman uncovers the ambivalence of the gaze that wanders between human body and picture when he describes the picture as the site of the gaze, even though the body cannot enter the picture itself. The vanishing point is "unoccupiable" by a person or indeed any physical object, but it gives a viewer "the possibility of objectifying himself, the means of perceiving himself, from the outside, as a unitary seeing subject, since each image makes a deictic declaration; this is how I see . . . from this particular spot at this particular instant in time."[10] According to Rotman, the indissoluble relationship between presence and absence also applies to zero, which can be considered a number only in the sense that it is a nonnumber. Thus the viewer of a painting experiences himself precisely in the place where he is not present because the picture leaves a space for him, a place that is at the same time empty—a gap. "Zero is written on the viewer's body, since only where there is nothing, but something could be, does he himself stand."[11] Between the tenth and the thirteenth centuries "the sign [0] stayed within the confines of Arab culture, resisted by Christian Europe, and dismissed by those whose function it was to handle numbers as an incomprehensible and unnecessary symbol," writes Rotman. But in the fourteenth century, "with the emergence of mercantile capitalism in Northern Italy, the handling of numbers passed . . . to merchants, artisan-scientists, architects . . . for whom arithmetic was an essential prerequisite for trade and technology."[12]

The invention of perspective—which occurred in Italy, the same place where the number zero was introduced to the West—belongs in the same environment. And so it makes sense to add a third element to Bryson and Rotman's arguments and to include the Arab genealogy of the visual theory that was introduced in the West at the same time as Arabic arithmetic. Rotman has already established this connection with regard to the vanishing point, but without including the translation of Alhazen's theory from Arabic as part of the evidence. Adding it makes the parallel he draws between zero and the vanishing point even more convincing, but its cultural and historical significance becomes apparent only when one makes an essential distinction: Zero already existed in Arab mathematics, but the vanishing point was first invented in Western art—because it makes sense only in a kind of picture that did not occur in Arab art. In the geometry of the visual field

as proposed by Alhazen, there was no conception of a screen located between the eye and the world; rather, light used countless points on the surfaces of objects and connected them with the surface of the eye by means of visual rays. The imaginary cone whose vertex lay in the center of the eye is not identical to the "visual pyramid" of perspective, which is bisected by the picture plane.[13] Alhazen had no need of a vanishing point for his theory, which exists only in the gaze, the act of seeing, but not in the world of objects. Nevertheless the geometrical point through which the world transforms itself into a picture became possible only within the framework of a system that could be calculated mathematically.

V.

The text of this book is structured as six chapters, each of which ends with a *Blickwechsel* to the other of the two cultures. The first three chapters place the Arab aspect of the subject in the foreground. Chapter 1 introduces the topic by examining the spectrum of possible meanings for the term "perspective" in art and science. I then offer a critical analysis of the term "symbolic form" and relate it to the concept of a "cultural technique." In the encounter between East and West, pictorial art—which was understood as the only "art" in the West—existed under different conditions than applied arts and crafts, in which transfer between East and West occurred more easily. The final section takes up an idea of Orhan Pamuk's and examines Ottoman society and its interactions with Western art of the modern period. Chapter 2 takes a stance on the question of pictures in Islamic culture, which is currently a subject of controversy even among experts. In the last section of Chapter 2, I contrast the dominance of the gaze in Western art with the visual taboos existing in the religion of Islam. Chapter 3 offers a first attempt to introduce Alhazen's visual theory into the scholarly discussion of perspective art and to shed light on the theory's cultural background. Here mathematics, which in the form of geometry served as the great subject of Arab art, occupies an essential place. In the concluding section of Chapter 3, I distinguish between the dark room that Alhazen used to study the pathways of light and the camera obscura of the seventeenth century; the latter caught the attention of the public as consumers of pictures, like audiences in modern cinemas.

Chapter 4 opens the investigation of perspective in the West with a discussion

of the epochal change that occurred when an Arab visual theory was transformed into the new pictorial theory of the Renaissance. The invention of mathematical space by the philosopher Biagio Pelacani of Parma played a key role in this transition. The final section here offers a reminder of how Euclid came to overshadow Alhazen in the cultural memory of the Renaissance, as a way of stressing classical antiquity as the West's sole heritage. Chapter 5 takes the subject of perspective outside the confines of art history to describe the significant role it played in the design of stage sets, for example, and the role of theater in Western visual culture. In each of the last two chapters the *Blickwechsel* serves to identify a symbolic form in Arab art: the geometric *muqarnas* in Chapter 5, and in Chapter 6, the window lattice of the *mashrabiyya*. Chapter 6 expands the spectrum of areas in which perspective has made its effect felt by discussing the history of the self-aware "subject" as a philosophical concept. The symbolism of the gaze emerges from the use of the eye as an emblem and culminates in the figure of a new Narcissus who has overcome the ancient fear of the gaze.

1

Perspective as a Question of Images

Paths between East and West

What Is a Symbolic Form?

New Questions. It was Albrecht Dürer who first introduced perspective—or more precisely, what is called "linear" or "mathematical perspective"—to the German public. As the roots of the word suggest, perspective created transparency, making it possible to *look through* pictures into the world they depicted. When we speak of central perspective we do not mean to say that a picture has some particularly important theme as its center, rather we mean only that its center is the gaze of a viewer. The measurement that was so important to Dürer, while it involved the proportions of the human body, was in the case of perspective a *measurement of the gaze* so that it could be "constructed" or "reconstructed." Thus artists who made use of perspective handed their new pictures over to the eyes of the public by simulating their way of seeing. In Nuremberg this was taken to be a new fashion in art from Italy, and everyone took it to have been invented in Florence, even though Dürer had learned about it in Venice. Who could have foreseen that one day it would become the *signum* of what distinguishes pictures made in the West from all others? The fact that this is so means, however, that the issue we are dealing with here is not a *question specific to art,* even though it became a subject of discussion in that field. Only when we recognize that it is a question of *pictures* does the cultural significance of the topic become apparent, for what cultures do with pictures and how they capture the world in them leads straight to the center of their way of thinking.

The pictorial invention that we call perspective was a revolution in the history of seeing.[1] When perspective turned the gaze into the umpire of art, the world became picture, as Heidegger would later observe. For the first time, paintings in perspective depicted the gaze that a spectator turned on the world, thereby transforming the world into a *view of the world.* The term "analog image," to which we

look back with nostalgia from the digital era, was first coined for photography. Yet as far back as the early modern period people recognized that the new kind of picture using the perspective technique was somehow "analogous" to our visual perception, even though the claim was a bold one. Pictures in perspective suggested—just like all the later images produced by modern technology—that we are seeing with our own eyes what we can in fact see only in the representation. Nevertheless people remained convinced that our perceptions of such pictures and reality truly were analogous. In a long run, the new pictorial techniques would conquer all the zones of reality that remained inaccessible to the human eye. At the start, however, perspective painting asserted a claim that it mirrored or duplicated our perception. The *iconic gaze* generated by perspective is not the gaze of an icon but rather a gaze that has been converted into a picture.

As a technique developed by human culture, perspective had an enormous impact. Through its aim to duplicate natural perception, it altered more than the world of art when it appeared on the scene. Its success led to the transformation of an entire culture. Images always possess a specific quality: they give their stamp to a particular culture just as much as they are stamped by it. This is also valid for Western culture, whose penchant for the visual has led to ever newer visual technologies. For a long time we thought this culture was universal, and it is only in the global era that we have been able to look at it in a different way. One could object that all pictures serve human vision. Yet perspective is different insofar as it represents the human gaze as such. It does so by way of a fiction, since our own powers of sight happen to be connected to our bodies, even if we like to feel disembodied as we let our eyes wander. Human vision cannot simply be transferred to an artifact. Thus perspective technique depicts a mode of seeing that by its very nature resists depiction.

Critics blame perspective for our "visual addiction" and point out that it is based on false premises, as well. Yet no matter how hard we try, we cannot break free of this inheritance from the Renaissance but remain hooked on visual conventions that the whole world regards as patented in the West. In fact globalization even corroborates perspective, as the medium in which colonial rule found self-expression. The invention of photography consolidated the predominance of mono-focal perspective more than ever before. The camera merely produced by mechanical means what artists had previously labored to devise. Its lens with a single eye corresponds to the viewing point of a picture in perspective, which is also mono-focal, and for that reason photography was most welcome as long-sought confirmation of the perspective model. Even in the digital era the visual

habit of seeing in perspective remains indispensable. Although perspective had already lost its scientific foundations in the seventeenth century, its popularity has continued without interruption. It would be tilting at windmills to object to a way of seeing that has become the norm around the world for approaching pictures, even though art and science have repeatedly challenged the foundations on which it rests.

Cultural discussions of the human gaze frequently encounter the objection that vision is inborn and hence could not depend on history and culture. Behind this argument lurks the well known controversy over nature and nurture. Framing the discussion in terms of these opposites misses the point, however, because every culture enlists human nature in its service (including human vision) and subjects it to the social norms of public and private life. Of course the Renaissance theory of perspective claimed to be based on nature and explained the gaze in terms of the function of the eye, which is incontestably a natural organ. At the same time, however, it turned the gaze into a symbol of self-interpretation, as the humanist Leon Battista Alberti did when he chose a winged eye as his personal emblem (see Fig. 87). This symbol privileges visual perception in acquiring knowledge of the world.

Symbolic Form. Perspective was a cultural technique and a matter of concern not just for artists, since it came to symbolize the right to perceive the world with one's own gaze. In this sense we can speak of a symbolic form in which the culture of the early modern period expressed itself. The perspective picture depicts three-dimensional space in a paradoxical manner, namely on a flat surface that does not exist in nature, because it cannot be separated from the human eye. This depicted space cannot be removed from the gaze because it is a function of that gaze and not the other way round. Perspective space is generated only by looking and for the purpose of looking, since it exists only on a surface that to start with is not spatial in character. Our real gaze functions in a bodily and spatial manner, but perspective symbolizes this gaze in two dimensions, using the picture screen as a symbol. Space in perception exists as space for the gaze. The picture plane in perspective art is a metaphor for the presence of an observer, who is constructed as a function of the picture.

In a famous study the art historian Erwin Panofsky identified perspective in art as a "symbolic form," using a term borrowed from Ernst Cassirer. In 1927, the date of Panofsky's essay, Cassirer was working on volume three of his *Philosophie der symbolischen Formen (The Philosophy of Symbolic Forms).*[2] Panofsky wanted "to extend Ernst Cassirer's felicitous term to the history of art."[3] The philosopher

himself, however, regarded *all* art, art in the general sense, as a symbolic form—along with language and myth—and did not mention perspective at all.[4] If one takes Cassirer's view a step further, however, then it was in fact perspective that made the art of the early modern period a *symbolic* form in the true sense of the word. This is to say that if art is a symbolic form by its very nature, then it holds true even more for modern Western art, which differs fundamentally both from the art of other cultures and from its immediate predecessor, the art of the Middle Ages, not least because of the invention of perspective. Nevertheless the concept of a symbolic form cannot be limited to perspective or to Western art. And we must also ask why Panofsky accented the role of space and not the gaze, since even early texts on perspective speak of the latter.

We must seek the answer to this question in the work of Cassirer, who begins each volume of *The Philosophy of Symbolic Forms* "with an examination of space and time following Kant's model."[5] In volume three Cassirer discusses space as a "world of pure intuition."[6] This helps to explain why Panofsky based his study on space rather than the gaze. When Panofsky speaks of "systematic space" he is developing an idea of Cassirer's, who had observed that "homogeneous space" is never a given but must always be constructed.[7] (Cassirer was in turn citing Ernst Mach.) Panofsky also admits that "the structure of an infinite, unchanging and homogeneous space—in short, a purely mathematical space—is quite unlike the structure of a psychophysiological space."[8] Yet he does not draw the conclusion one might expect—that perspective constructs a space in precisely this manner but is not itself a space. Ernst Cassirer regarded homogeneous space purely as a "task for logic," but argued that one could not speak of homogeneity at all in a physiological space such as a visual or tactical space.[9] In fact, as Panofsky had to concede, the geometry of perspective "takes no account of the enormous difference between the psychologically conditioned 'visual image' through which the visible world is brought to our consciousness" and the pure retinal image.[10] It is precisely in this dissimilarity, however, that the difference between symbol and fact becomes apparent. If we accept this distinction, then geometrical perspective is a symbol of the gaze and not a perceptual tool. Whereas the natural world is characterized by an unpredictable flow of visual phenomena on which no logical schema can be imposed, perspective depicts the world as only the imagination can see it. It constructs the world for a symbolic gaze.

Seen in this light, perspective is more an invention than a discovery. Panofsky casts doubt on the unique and novel character of this invention, however, when he credits (European) antiquity with having developed its own form of perspec-

tive and raises the possibility that painting "at least by late Hellenistic and Roman times, had just such a procedure at its disposal."[11] No such procedure could have existed then, however, because the ancients did not possess the mathematical knowledge that became available in the West only when the Arab theory of optics reached it. During the Renaissance the significance of Vitruvius's scenography became a subject of controversy, and some projected onto it an earlier equivalent for their own perspective art (see p. 161). In his work on architecture the Roman writer was concerned with stage sets, where painters could produce the impression of architectural structures on a flat surface as if by magic—that is, create an illusion. Similar texts from antiquity deal with optical illusions, for example when they mention the foreshortening of a row of columns, which occurs in the eye despite all knowledge to the contrary. Seneca laments the fact that "nothing is more deceiving than our eyesight."[12] Wall paintings in Pompeii successfully brought the technique used for stage sets into private houses. It was a medium for creating illusions, but it does not furnish an example for the existence of a standardized perspective, especially since the procedure used in Pompeii changed with each new generation. When perspective technique came to be used in stage sets during the Renaissance, both its mathematical basis and its connection to science were new.

Although perspective was not unique to the early modern period, in Panofsky's eyes, he did regard it as "a factor of style" that distinguished different "artistic periods" from one another.[13] This argument negates the cultural significance of the invention, however, not to mention its scientific foundations. Although Panofsky states that perspective seeks "to construct pictorial space . . . out of the elements of, and according to the plan of, empirical visual space,"[14] he contradicts this claim himself in another passage, when he concedes that making an analogy between perspective and our visual perception is a bold abstraction from reality; as noted above, Panofsky was aware of the "enormous difference" between visual images and "the mechanically conditioned 'retinal image' that paints itself upon our physical eye."[15] This is why he considered space to be an autonomous symbolic form that does not represent a fundamental empirical experience. He failed to appreciate, however, that the space of Euclidean geometry and mathematical space were different, and it was not until the eve of the early modern period that Biagio Pelacani (sometimes known as Blasius of Parma) invented the latter (see p. 146).

The perspective of the early modern period was a symbolic form because it laid the foundation for a new conception of what a picture is. Gottfried Boehm saw it

as the expression of a "cognitive revolution": By granting viewers a privileged location in front of the picture, perspective also endowed them with a similarly important place in the world.[16] As a result it became the expression of anthropocentric thinking that liberated itself from the theocentric worldview of the Middle Ages. The Renaissance represented the human subject, whom it celebrated as the individual, in two ways, once by painting portraits of individuals and once by painting the viewer's gaze. The portrait and perspective are independent of each other, but they were invented at the same time. Both grant a symbolic presence to a person in the picture, the former with the face as it appears in the portrait and the latter by depicting an individual gaze. Both perspective and portraiture are symbolic forms.

Problems with Perspective. It has become customary for art historians to speak of the art of both the Middle Ages and the Eastern Orthodox Church as having a different kind of perspective. Yet we create a trap for ourselves if we unintentionally make perspective the sole standard and then measure counterexamples using the same term. "Lack of perspective" is a questionable concept, since it implies a need to explain why "no perspective" existed before the Renaissance or outside the West. Similar reservations apply to such terms as "anti-perspective" and "reverse perspective." The German art historian Oskar Wulff used them to characterize the Middle Ages, and following his example the Russian philosopher Pavel Florensky applied them to icon painting. But how could something be "reversed" if it hadn't been invented yet? The argument for recognizing a "perspective of hierarchy" in medieval art is also questionable unless one is using the word "perspective" in an entirely metaphorical sense. The meaning of the term cannot be arbitrarily expanded or inverted. Furthermore it is far more natural to organize pictures according to the internal significance of their various elements than to make them dependent on external categories. We must free ourselves from perspective as a norm and cease to label everything else as a deviation. In Arab culture, symbolic forms can be identified that differ greatly from perspective, if only for the reason that such forms have nothing to do with pictures in the Western sense. This will become clear in the discussion of the *muqarnas* and the *mashrabiyya* (see pp. 204 and 252).

The *perspectivism* of the modern era that is associated with the name of Nietzsche originated as philosophical criticism of the claim that only one perspective could represent truth. Perspective here was understood metaphorically as a "correct" grasp of the world—and criticized for precisely that reason. Already in the seventeenth century Blaise Pascal had expressed his regret that painterly perspec-

tive could not be transferred to truth and morality. Because he lived in the baroque period and was surrounded by art that depicted a deceptive world of illusion, especially in the form of anamorphosis, Pascal missed having a fixed point of view for truth. This search had changed by the time of Nietzsche, who regarded every standpoint as arbitrary.[17] There was no corner from which one could see the world in correct perspective. And Nietzsche was not alone in his "opposition to mono-perspectivism."[18]

Modern art found its own identity in opposition to perspective pictures in popular culture, and cast perspective aside as unnecessary baggage that was impeding "progress." Fritz Novotny saw the birth of modernism in Cezanne's struggle against perspective, which had shackled painters for too long.[19] Werner Hofmann understood the adoption of multiple perspectives—the depiction of several surfaces in a single picture plane, with its affinity to medieval art—as a liberation from outdated constraints on vision. In a wide-ranging study he proposed a revised view of central perspective as representing a long intermezzo between medieval and modern art.[20] And indeed modern artists rebelled against linear-perspective realism at the same time that scientists were overthrowing the traditional view of the physical universe. Another movement in the early twentieth century was primitivism, which discovered the art of "primitive" peoples and helped lay the groundwork for cubism; as reflected in the work of the young Picasso and his fellow painters, it reveals a longing to break away from the academic conventions of perspective, which they despised as banal and clichéd. Paradoxically, in other parts of the world this very same realism was being proudly introduced as an achievement of the modern era (see p. 45).

The philosopher Maurice Merleau-Ponty once criticized André Malraux's concept of universal art,[21] recalling the fact that perspective existed at first within cultural limits and could therefore not be universal: "Sometimes Malraux speaks as if 'sense data' had never varied throughout the centuries, and as if the classical perspective had been imperative as long as painting referred to sense data. Yet it is clear that the classical perspective is only one of the ways humanity has invented for projecting the perceived world for itself."[22] By giving up the freedom of perception, it bound itself to a single standpoint and an "immobile eye." It "is the invention of a world dominated and possessed through and through by an instantaneous synthesis."[23] Linear perspective is not universal but rather tied to a particular culture.

In our time artists play with the clichés of central perspective, openly treating them as fiction. The film director Peter Greenaway, who began his career as a

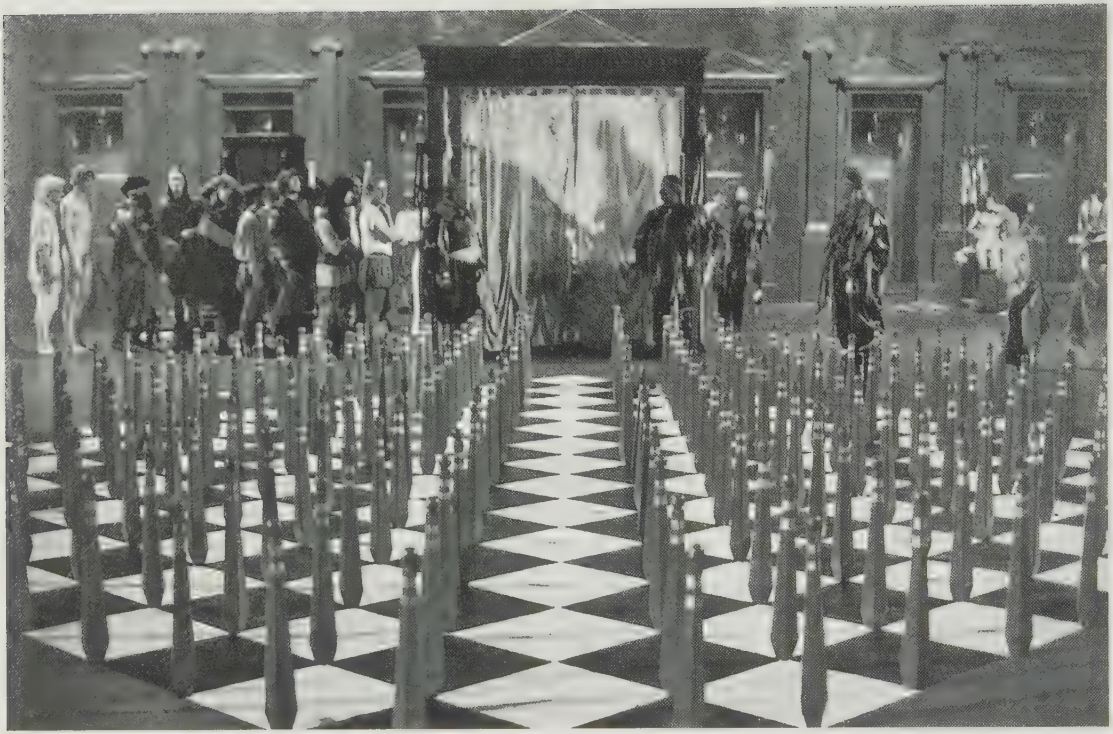


Figure 1: Peter Greenaway, The Baby of Mâcon, 1993, shot number thirty-nine (Black Forest Films).

painter, provides a pertinent example. In his films he performs "perspective theater" in strange, hallucinatory settings, playing with perspective in ways he has encountered in the art of the baroque. At the same time perspective is a trick, an illusion, and a "pathos formula"—to use Aby Warburg's term. This holds true especially for the film *Prospero's Books* from 1991, an adaptation of Shakespeare's *Tempest.* There Greenaway uses various pseudo-perspectives to conjure up before our eyes an island of the imagination in an illusory world filled with a virtual encyclopedia of cryptic allusions.[24] In 1993 he continued to play with conventions in the film *The Baby of Mâcon;* look at shot thirty-nine, for instance, which takes place in a guard room and features a perspective set with chessboard floor tiles and 208 large objects resembling bowling pins. This set is related to the plot and represents the prison of fate (Fig. 1).[25] The plot turns on the fact that each pin, as a phallic symbol, refers to the violent acts occurring in the bed behind the curtain. If one imagines each bowling pin as equipped with an eye at the top, then suddenly all of them seem to be focused on the bed.

In the mass media the clichés of central perspective have proved to be an en-

during recipe for making illusions look like documented truths. The practice in choosing images for mass production has not strayed from the familiar paths of perspective, not least because such pictures from the West have circled the globe. Visual media—television, for example—satisfy a trained global public's need for illusion by adapting technology to the visual conventions of the West. "The TV screen has internalized the concept of central perspective by giving the vanishing point a material existence as a picture generator in the cathode ray." And it has done so even though the picture is generated in a completely different way, namely by being "shot into space, captured by converters and briefly arrested in a grid. And so the tube is also the new location for an altered perspective, according to the lines of flight of one sequence. Now the gaze lights on the crowded artificial horizon of a monitor."[26]

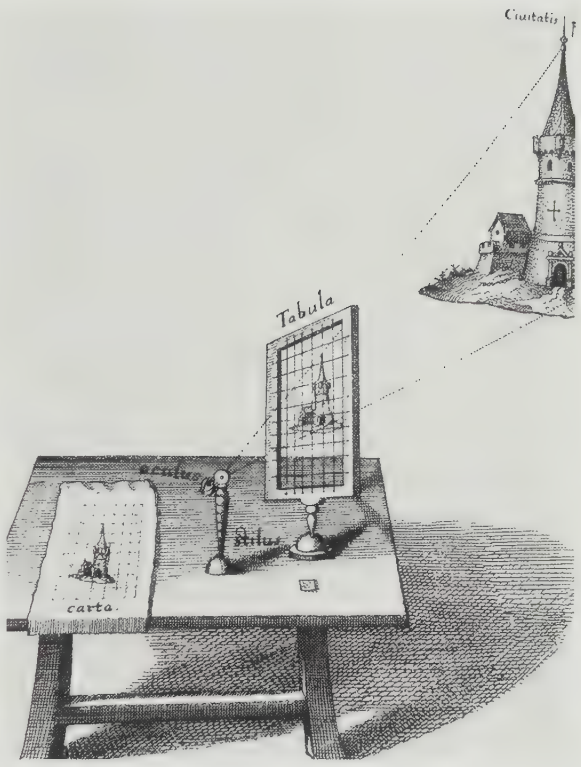


Figure 2: Robert Fludd, Utriusque cosmi historia, 1618: Perspective as a system, with a sheet of drawing paper, pen, eye, picture plane, and motif (public domain).

The Visual Pyramid and the Formula for Perspective. At this point it is necessary to embark upon a small digression and review what can be considered the method of linear perspective. Readers who are already familiar with this material may skip over the excursus and go straight to the next section.

The window is an obvious choice as a metaphor for the principle of perspective.[27] A glazed window is both a surface (of glass) and an opening in a wall onto a particular space, just as the new type of painting in the Renaissance was a surface onto which an imaginary space was projected, as if a facsimile of what we see with our eyes could exist. The Englishman Robert Fludd, who was not an artist himself but the compiler of an encyclopedia, illustrated the principle of perspective in grotesquely simplified form for a general audience in 1618: A screen divided into squares *(tabula)* depicts a view of a town at a distance from the eye *(oculus)* of an artist (Fig. 2). Attached to the eye is a pen *(stilus)* that transfers what the eye sees, square for square, to the sheet of drawing paper *(carta)* on the table, and so the image is produced.[28] This schematic diagram reduces the complex opera-

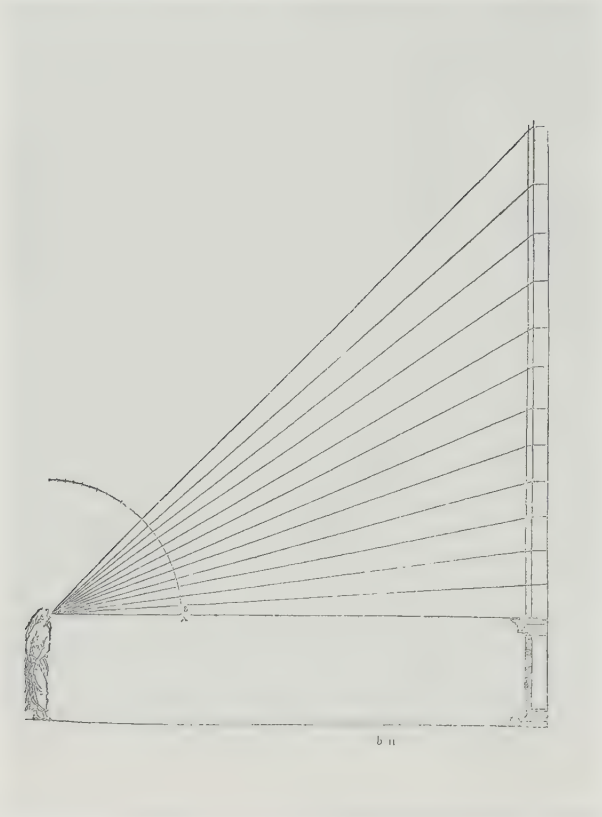


Figure 3: Sebastiano Serlio, Le premier [-second] livre d'architecture, Paris, 1545, 10r: Illustration of perspective (Collection Centre Canadien d'Architecture / Canadian Center for Architecture, Montreal).

tion involving the eye, the hand, and the finished picture to a purely mechanical one.

Fludd's illustration is based on the idea that a drawing or painting represents a plane intersecting the visual pyramid. This pyramid has its apex at the eye and is constructed of visual rays, or straight lines, while the hypothetical intersection of the pyramid—the picture plane—can be placed at any distance from the eye. Perspective can be described as a method for constructing visual spaces. It was often used by architects, who oriented the elevation drawing of a building facade toward a particular standpoint. In his famous treatise on architecture Sebastiano Serlio (1475–1554) simply equates the principle of perspective with the "scenography" used by Vitruvius in ancient Rome (see p. 161).[29] The accompanying drawing shows an eye dividing an architectural element into twelve units of measure with a fan of visual rays (Fig. 3).[30] The anatomical eye is not the active factor here, however, but rather what is called the "eye point," because Serlio needed a fixed point from which to measure distances in the physical world. The illustrator conceives of it as a geometrical point located not on the body but just in front of it. It marks the point from which measurements can be checked, which Serlio distinguishes from the eye: "The distance must always be measured at the height of our eye," that is, not in the eye itself. "Whatever is removed from our view *(veduta)* grows smaller as the atmosphere weakens our sight." The distinction between the eye and the view was necessary because perspective is a geometrical model of representation that functions mathematically and not physiologically.

In 1583 the mathematician Egnatio Danti of Bologna published *Le due regole della perspettiva pratica* (The Two Rules of Practical Perspective) as they had been calculated by the architect Vignola.[31] The first rule is concerned with the "dis-

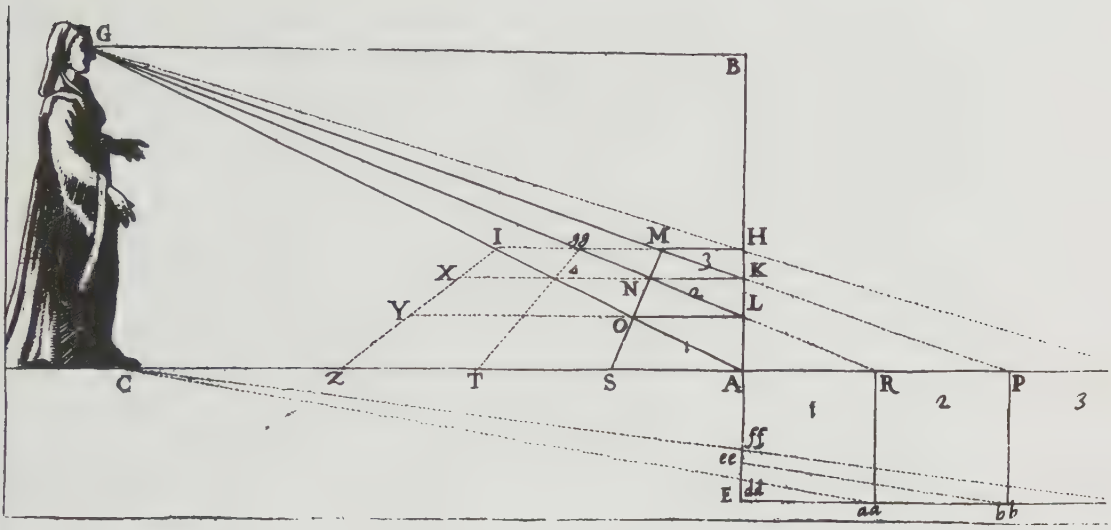


Figure 4: Jacopo Barozzi da Vignola, Le due regole della prospettive pratica, 1583: Illustration of the first rule (© The British Library Board).

tance point," which in this case is marked on the "horizon line." The terms themselves are axiomatic and establish geometrical points on living bodies. In the accompanying illustration Vignola depicts a formally dressed woman (Fig. 4). At the height of her sketchily drawn face the *eye point (G)* indicates the apex of the visual rays, whereas the *distance point (C)* in the drawing determines the distance of her body to the picture plane *(A–B),* which is conceived of as an intersection through the visual pyramid. The space is pure image and originates solely in the woman's gaze. On the painted surface the visual space and the picture plane become synonymous in the gaze, despite their dissimilarity in actuality. One sees a space while looking at a surface. Since "we cannot actually see ourselves seeing," we must choose between the diagram and our own perception. "The construction allows us to see the ideal eye point but cannot provide the means for us to see it and to see through it [i.e., into the world—HB] at the same time."[32] We are either disengaged spectators or agents doing the looking, but in the second case we no longer see the construction represented in the diagram.

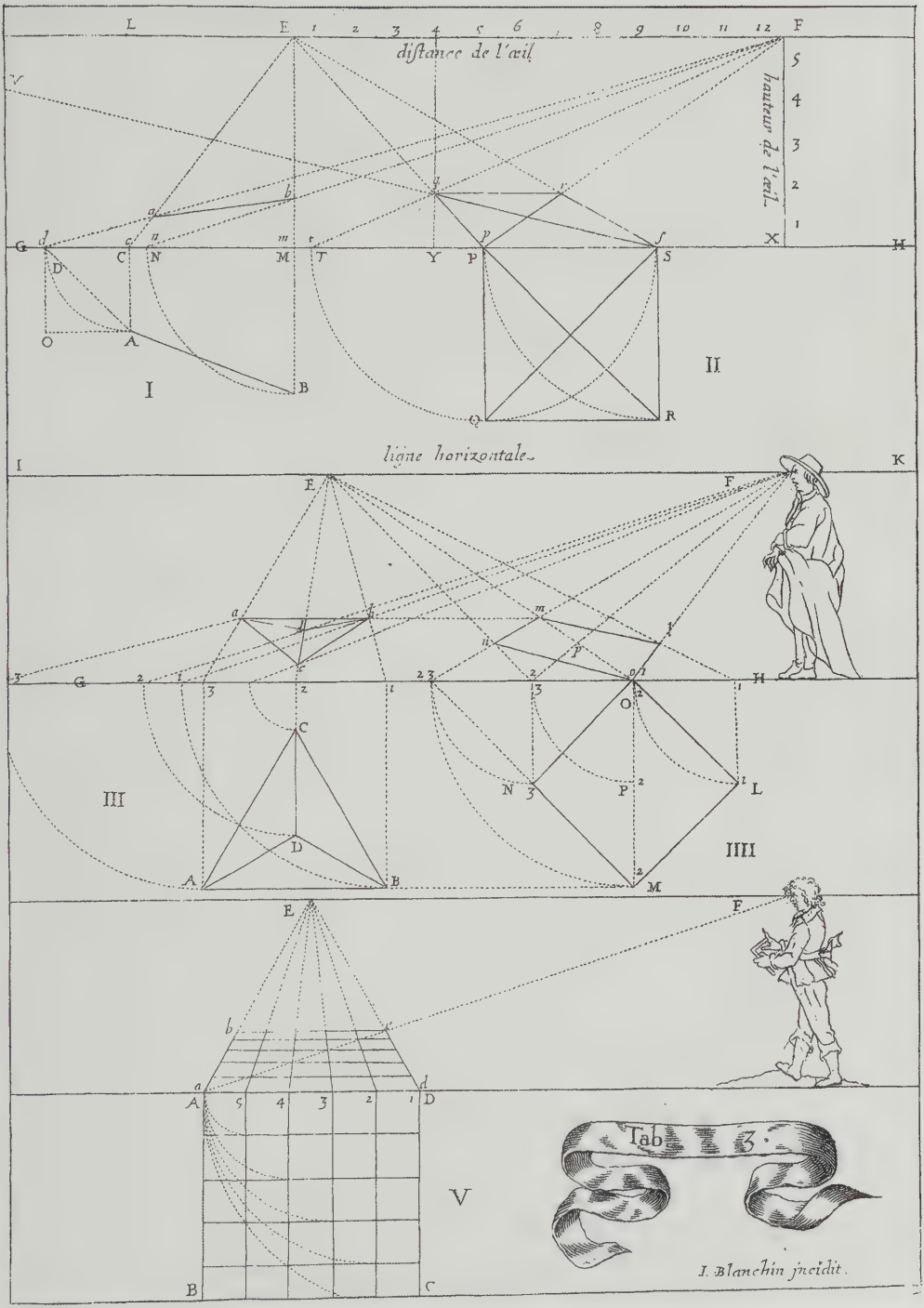
As the third and last in this series, Jean-François Niceron should at least be mentioned. Niceron published a virtually encyclopedic collection of perspective diagrams and methods entitled *La perspective curieuse,* in which he varied the "rules" and occasionally undermined them. Niceron was interested in playing with "normal" or "usual" perspective. In book two he says that until then the screen or picture plane had always been placed between the eye and an object, but that he wants to experiment with locating the object between the eye and the

picture plane. Orthogonals can now run toward the viewer instead of leading away from him into the distance. The eye is now surprised and entertained with a wealth of variations for which there are new rules. In Table 3 of his work Niceron varies Vignola's second "rule" and places the distance point *F,* namely the observer's eye, differently in the section of the diagram at the bottom than in the two sections above (Fig. 5).[33] It is thus not the case that perspective was established early on, once and for all. Rather it became the basis for a panopticon of effects including anamorphosis, which occupied an important place in Niceron's work. He represents the point of departure for a long development that transformed the first perspective theory of pictures into a theory of playful variations.

In a perspective picture the eye point and the vanishing point, which are both geometrical concepts and do not exist in nature, are situated directly opposite one another.[34] Because we obviously have two eyes, a single eye point cannot be located on the body, just as at the other end of the visual path no vanishing-point can be found in the real world. The gaze, with its finite extent, is directed toward this infinitely distant point on which the orthogonals converge, so that a polarity arises between *here* and *there.* In the process the gaze is aimed beyond the distance it can actually reach. Robert A. Romanyshyn calls the vanishing point a "launching pad" on which the subject becomes an astronaut.[35] In the gaze, an observer grants himself the right to look at the world from an external position, so to speak. He cannot be physically present at the point toward which his gaze is directed.[36]

Figure 5: Jean-François Niceron, La perspective curieuse, 1651, Table 3: Different options for perspective (Research Library, The Getty Research Institute, Los Angeles [87-B20691]).

Neither on the spherical retina nor in the head does a surface exist such as that of the perspective painting. Kepler accused painters who assumed visual rays to be straight lines of neglecting the curvature of the retina, since in reality only curves are observed (see p. 124). Our visual images, as Joel Snyder observes, do not behave like the pictures that perspective depicts.[37] It was an unwelcome discovery when Descartes found the retinal image in the eye of a cow (see p. 125). The Renaissance still distinguished the perspective painting from the process of seeing, using the Latin terms *pictura* and *visio.* But when Kepler discovered a purely optical image on the retina that had no correspondence either in the external world or in the brain, he equated the two terms. His retinal image has nothing more in common with the image as conceived by the perspective technique; instead it opens a gap between the eye and perception—one that he had already encountered in Arab science, as we shall see (see p. 107).[38] Movements of the eye muscles make what we see stand in sharp contrast to pictures, representing an immobilized gaze. The area we see in clear focus shifts when the muscles of the eye move,


distance de l'œil
hauteur de l'œil
ligne horizontale
I
II
III
IIII
V
Tab. 13.
I. Blanchin jn.et dit.

whereas perspective produces a static image. For this reason the format of a picture could not exceed the angle of vision.[39] As the view before us changes, our perception occurs in a fragmentary and fleeting way. The perspective method took none of these circumstances into account.

A few years before the shift in thinking associated with the names Kepler and Descartes took place, we find the old state of affairs summed up by the artist Giovanni Paolo Lomazzo. In a work entitled *Idea del tempio della pittura* (Idea of the Temple of Painting) he distinguishes between the kind of perspective "called universal" and a specific kind that serves to represent the world as it is perceived. The artistic "logic of vision" *(ragion del vedere)* consists in a "correspondence to the eye," which measures the world in distances. In this method, he says, we can "see neither more nor less than we can see in reality." Given perspective's method for representing three-dimensional objects on a flat surface *(in piano)* the eye must "take up a position *(si colloca)* where we can see things best." That is the location of perspective, a geometric location from which artists "can produce foreshortening." In both cases "painting must invent a depth that is nothing other than a hollow in the picture surface. It attacks the walls and gives rise to the impression that no walls exist at all."[40]

Arab Mathematics and Western Art

We now leave the familiar paths of the history of linear perspective and turn to a question that will show our topic in a new light. In the process, the profiles of two cultures will emerge that once possessed a shared theory. The idea that geometrical perspective was "invented" from the ground up in the Renaissance is a myth. In fact it had been introduced to Europe in the Middle Ages by the Arab theory for which translators into Latin used the term *perspectiva.* The main work of the mathematician Alhazen (965–1040) bore the title *Perspectiva* until 1572; only then was it changed in a printed edition to *Optics,* the Greek term by which the study of light and visual perception is still known today (see p. 92). Before that date, "perspective" referred to a theory of vision that did not deal with pictures or images. This fact has been lost to cultural memory except among specialists in the history of science. The Arab provenance of optics did not fit well with the way the Renaissance saw itself—or the way we tend to see it—as reviving only the

legacy of classical antiquity. All the same, the transformation from a *scientific theory* into an *artistic practice,* from an Arab *visual theory* into a Western *pictorial theory* was a quantum leap. It raises the question of how two cultures came to have this historic encounter, cultures that had and have a completely contrary relationship to images and the gaze.

The Renaissance changed direction dramatically when it reified vision, using a grid of invisible coordinates, the "visual rays," as an underlay for their pictures. The term "perspective" lost its former scientific meaning and became the key word for a new technique for making pictures. Since this connection is ignored for the most part, an investigation of it opens up a new topic in cultural history. The models that a given culture favors in both theory and practice are a form of self-expression. In sum, we can say that the Arab theory of optics was about light and the laws that govern it, whereas the Western theory first made it possible to create a visual image based on measurements of the human gaze. Hence in what follows I will distinguish between the Arab science that *measured light* (Chapter 3) and the Western art of the Renaissance that *measured the gaze* (Chapter 4).

The transmission of the mathematical theory of optics to the West also reveals the complexity of the relationship between science and culture. On the Arab side an *aniconic* culture aided scientists in their efforts to free themselves from concepts of ancient optics and concentrate on the geometry of light, which is nonpictorial. The Renaissance, in contrast, pursued science in an environment saturated with pictures. With the mastery of perspective Renaissance artists acquired a new technique that strove to demonstrate in pictures the conditions of human vision for everyone. Their art was regarded as an applied science, and this alliance with optics did not end until the age of Kepler (see p. 124). The Western way of thinking expressed itself in pictures, while the Arab theory of vision did not address the subject of pictures. If we take seriously the Arab taboo on pictures and the Western desire for pictures, it becomes clear why this has become such a sensitive issue. We can speak of two visual cultures that differ precisely on the question of images.

Usually we treat the history of science as a separate discipline, but this division should not be as categorical as the theory of "two cultures"—meaning the humanities and the natural sciences—would have us believe. No branch of science is immune to the culture in which it is practiced and to that culture's worldview. Thus we are dealing with culture in the sense of mentalities and visual conventions that characterize different fields of research, on the one hand, and on the other, with culture in the sense of societies that existed in specific historical ep-

ochs. Our understanding of Western culture comes into sharper focus if we take a step back and examine a crucial encounter with Middle Eastern culture, as occurs in this study. Such an encounter cannot be properly appreciated if we reduce it to an instance of "influence" by a foreign culture on our own. Only a *Blickwechsel* (a shift of the gaze from one culture to another) can reveal the characteristics of two cultures that make different use of the same knowledge.

We enter uncertain territory, however, when we apply the said *Blickwechsel* by shifting our gaze to Arab culture, the culture whose visual theory stood behind the development of linear perspective in the Renaissance. The theory had been discussed for two centuries before Renaissance art set about turning it into a pictorial theory. Now *perspectiva* suddenly became a method used by Italian artists for taking spatial measurements. The result of this new alliance between science and art consisted of what we would today call an "analog" image, analog in the sense of the natural way of seeing that the artists were striving to copy. A painting composed in conformity with the principles of linear perspective is both an artifact and a facsimile of perception. But the use of a picture was foreign to the Arab theory. It regarded the eye as an organ that could be deceived, one that needed the contribution of the *inner* senses to complete the task of perception.

The contrast between Arab visual theory and Western pictorial theory existed for cultural rather than scientific reasons. In Middle Eastern culture, making pictures in the Western sense was long regarded as taboo, while in the West it was celebrated as the royal road to knowledge. The Arab theory was not concerned with pictures or images but with visual rays, which were thought to convey a mosaic of tiny signals point by point to the eye. The step taken by the West was thus all the greater when it shifted the accent from a fallible and passive eye to an active gaze, one that did not allow itself to be deceived but confirmed its perceptions by taking measurements. This process promoted a new notion of space, understood as something both measurable and linked to an observer and his location. In the coordinates of this kind of space, the world is visible to an observer who can orient himself within it and equate it symbolically with the space that his eye perceives. This example shows how differently visuality was understood in the two cultures.

It is easier to perceive a culture as an entity when one observes it from a distance than it is to make statements about the culture in which one lives. If someone were to look over from Arab culture to the West, then he would have to ask why pictures possess such central importance here and have persisted through-

out all historical epochs. The question cannot be answered with reference to the modern period alone, since the answer was given much earlier. In his history of the senses, David Summers pointed out that patterns of thought from antiquity have reasserted themselves in the West time and again.[41] "The primacy of vision" was one such successful model. In antiquity a fixation on the sense of sight, on its joys and terrors, led to acknowledgment of the power of the gaze and a desire to protect oneself from the gaze of others (see p. 101). Despite its roots in Judaism, Christianity adopted Greco-Roman pictorial culture and granted images a privileged status, although this was often controversial. From that point on, one can speak just as much of a "cult of pictures" as of "pictures for the cult" (in the sense of a religious practice).[42] Nothing else can explain the tenacity with which the Renaissance wrested control of images from religion yet maintained their privileged status in fields such as art and science. There too images continued to enjoy a primacy that no text could successfully challenge. Their power increased when they joined forces with the gaze. By incorporating a personal gaze, pictures confirmed the right of individuals to free themselves from the powerful official viewpoint of church and state. By depicting the gaze, perspective taught everybody to understand the world as an image or to make the world into a picture of one's own.

The Arab scientists had constructed a geometric system of light rays and visual rays based on mathematics and their own experiments, a system that corresponded perfectly to the abstract spirituality of their culture. Their theory treated vision as a *process* whose end result was always uncertain, since it depended on the atmosphere and many other conditions. For this reason they necessarily found suspect any pictures that stabilized perception and reified it as an artifact. They had no wish to single out any moment in perception from the constant flow of impressions, nor did they consider it possible. In Alhazen's view images did not originate in the eye, in any case, but rather in the imagination, and the imagination in turn was located in the realm of the inner senses. The product of the imagination could not be represented in pictures that address the external senses. Images originated only beyond the barrier between the eye and imagination, in the brain, a site that a theory of optics did not reach. The "errors" of the eye, to which Alhazen devotes the third book of his great work (and among which he tellingly includes illusions in art), are overcome through the synthesis of the internal senses investigated in book two (see p. 107). Overstating things a bit, one could say that in the Middle Eastern way of thinking a visual image meant a mental image *with*

which one sees, and not one that is *before one's eyes.* It could not be made visible because it did not occur in the external world. In the West, *analog images* became the model for all images, but for Alhazen they did not exist even as a possibility.

The *imagination* was appraised just as differently in the two cultures. It was linked to the eye in the West, too, but in Arab culture it became its own world more decidedly and with fewer compromises. In the West the gaze is inseparable from pictures, and becomes active itself in visual perception. It is possible to make pictures that are representations because perception transforms the world into pictures. A pictorial theory always requires a subject who becomes part of the visual process by acting with the gaze. In the Arab culture, light dominates the world and the eye is a light-sensitive organ. Alhazen therefore completes his mathematics of perception with a psychology of the internal senses, the point where the optical evidence ends. Internal images are of a different kind. In the Western sense they are not pictures at all, but for Alhazen they are the only images, since none occur in the world.

As the generator of inner pictures, the imagination has played a completely different role in the two cultures. Premodern Western culture set a demarcation line between the imagination and perception, assuming, for example, that the imagination functioned in dreams when the outer senses were suspended and blocked by sleep.[43] In Arab theory, in contrast, even visual perception during the day could not be separated from the inner senses. For precisely that reason, what we see could not be caught in pictures depicting the visible world. The two cultures saw the relationship between the gaze and the eye in different terms. Only in the West do the gaze and the eye constitute a unity. Here the gaze acts with the eye, with which it enters the world. The gaze is curious, bold, and susceptible to seduction, and hence also resistant to control. And it seeks pictures in which it possesses the world. The question is whether one can speak of a gaze in the positive sense at all in Arab culture. The many social and religious limitations imposed on the gaze suggest the opposite.

In my argument the issue of pictures acquires a significance that the history of science has not yet granted it. In that regard Arab culture drew back from the optical stimuli of the external world when it strove to protect the power of the imagination from the senses. A drawn or painted replica of internal images could only be an idol, since it was nothing but a forgery. The human eye could not receive integral images; rather it was understood to provide only the raw material for pictures, namely the optical stimulus of the "forms" transmitted from objects as

points of light and color. (Scholastic philosophers used the term *species* in Latin; see Chapter 4.) Paintings using perspective technique were thus necessarily regarded as idols when they became known in the Arab world. Such works could compete neither with the living creation in which people existed, nor with the production of mental images, which remained a mystery of human nature.

We speak of *central* perspective because the "center" of such paintings is always the viewer. His gaze forms what art historians refer to as the vertex of the visual pyramid. Hence such a gaze must always be represented in a perspective diagram if it shows the pyramid from another angle. As we saw, the gaze is at the same time a geometrical point that the eye occupies without actually being the point itself: otherwise it would be impossible to construct a geometry of the visual field that operates with orthogonals and the vanishing point of our perception (see Fig. 4). One needs a point, rather than the eye itself, to construct lines and angles. In the process, the world is calculated as a world seen. A geometry used for pictorial perspective marks a departure from Arab geometry, which had a different history and a different meaning. Arab geometry functioned as a filter for the path of light and as a key for creating complex mathematical patterns on surfaces. Thus this kind of geometry was not related to a human gaze; instead it possessed an autonomous structure that Western viewers consider abstract because they cannot relate it to themselves.

This also accounts for the different role each culture assigns to mathematics in its respective art. For Western eyes, which are unfamiliar with the translation of mathematics into aesthetics—or were, before the modern period at least—the degree to which mathematics dominates the world of the senses is astonishing. It stands as a calculation behind the patterns that cover the entire surfaces of Arab buildings and decorated objects. What we, still influenced by our past as colonizers, tend to dismiss as craft work occupies the same place in Arab culture that paintings do in the West. Artisanal products claim the same semantic status that we grant to art. We are thus not dealing with mere ornament or decoration void of meaning, but with an entirely different way of representing meaning. Geometry is calculated to organize surfaces, and so the latter are the symbolic site of this art, which shifts to three dimensions and reflects light only in the niches and vaults of the *muqarnas* (see p. 204). Mathematical equations do not link abstract with figurative but rather abstract with abstract.

Geometry in Arab culture has become a symbolic form in the same sense that pictorial perspective was in the Renaissance (see p. 15). It does not depict the

world in a mimetic manner, and it is a symbolic form in the way it raises mathematics to a cosmic law. The popularity of mathematics at the court in Baghdad, which influenced even the reform of Arabic script, offers reason enough to reflect on its role as a cultural practice (see p. 113). In the West, by contrast, mathematics in perspective was used mostly as an underlay for pictures, to make images seem even more corporeal than they already were. Mathematics is a subtext of the pictures but not their meaning. This dualism of subtext (mathematics) and text (picture) would lead, in the course of the Renaissance, to a division in the world of pictures and to the birth of the technical image. At the start it was only a by-product of the new visual culture, but as science mobilized it, the technical image undermined the monopoly of the work of art. Since the seventeenth century, diagrams, charts, and graphs have come to compete with realistic depictions because the parts of nature being studied became less and less visible to the naked eye. New ways of representation were required. At the "border lines" of what counts as reality and must be documented, art and science have followed separate paths since the Renaissance.

In preparation for my *Blickwechsel* between two cultures, it is necessary to mention two fundamentally different practices in geometry. The first is *represented* geometry, which is itself—for reasons that we will deal with later—a theme of official art in the Arab world. The motifs of this geometry are polygons and circles placed alongside one another, then developed from and divided by each other on the surfaces that they fill. Clean solutions had to be found for filling and dividing the surface (one being the condition of the other) no matter how large or small it was and without regard to its site. In this conception, geometry presents itself as a universal principle that takes precedence over the arbitrary location in which it is employed, be in architecture or in the ornamentation of artifacts.

In the Ottoman album of architectural drawings from about 1500 that was discovered in the Topkapi Museum in Istanbul (see p. 121), the leitmotif is the representation of geometry—geometry for its own sake. One example is a square in which a grid of straight lines and a set of circles divided by twelve radii are integrated perfectly on the basis of mathematical calculations (Fig. 6).[44] The frame and what it encloses do not stand in a contrapuntal arrangement to each other but belong to the same ordering system. The line of the frame is a measuring point but not a boundary, perhaps better described as an open border. The question of whether or not this is a picture in our sense is not applicable, but it does come into play in an Ottoman wall hanging from the sixteenth century. The two-tone allover pattern is in principle closely related to an architectural drawing, despite

the fact that the craft has shifted from architectural ornament to weaving (Fig. 7).[45] Suddenly we notice that in the case of the wall hanging a narrow frame has been inserted that changes everything, since it has been laid over the pattern rather than forming part of it. It is unmistakably a *picture frame,* and it turns the self-contained pattern that we now see within it—or "behind it," so to speak—into a picture for a viewer standing in front of it. At the time of the Renaissance two different orders of viewing and two cultures collided in an Ottoman workshop in Bursa, in one and the same artifact.

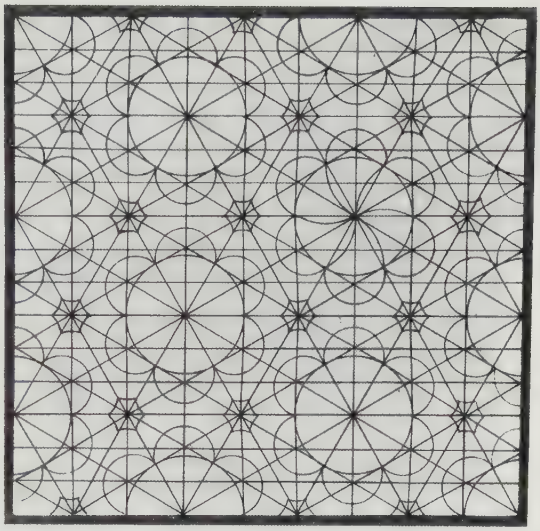


Figure 6: An architectural drawing from a scroll in the Topkapi Palace Museum, Iran, ca. 1500 (Gulrü Necipoğlu, The Topkapi Scroll, Getty Center for the History of Art and the Humanities, 1995).

If we now turn to geometry in Western culture, we are dealing with *representational* geometry, in the sense that geometry underlies pictures and serves to depict the world, that is, the nongeometrical world of the visible. To achieve this goal, the geometry takes possession of the three-dimensional space that we inhabit with our bodies and uses an external standpoint as a starting point for measurements, a standpoint that can be occupied only by a human being looking at the picture as if he or she were looking at the world. This standpoint serves as a basis for measuring distance geometrically, namely the distance of objects from the eye (see Fig. 4). The objects, physical substances, are determined by their size in perception and not by their size as such. Their size can be calculated only when their location is indicated in the visual image by means of orthogonals and transversals. For this purpose one needs a three-dimensional space with distances instead of a two-dimensional surface with an outline. The result of this operation is what we have called a picture since the Renaissance: a picture in, and of, the gaze. However geometrically it may be constructed, through the process it becomes figurative and three-dimensional in appearance.

Both cultural techniques, pure geometry and the applied geometry of central perspective, represent symbolic forms that reflect different mindsets. For that reason the objects we perceive acquire a totally different status in each culture. In the Arab theory they are dissolved into a mosaic of points with specific qualities, which makes our perception changeable and uncertain. In particular, the distance at which we see them creates uncertainty of a specific kind (see p. 106). In the

pictorial theory of the West, however, distance is a reliable factor for making measurements, a factor in representing everything. If we know how distant an object is from our eyes, then we can calculate its shape and size. Certainty about objects results only when they have a calculable location in space (this appeared as a victory over the human eye's vulnerability to deception). Space of this kind is always linked to the gaze. In the gaze, objects acquire an orderly relationship both to us, as observers, and to one another in terms of placement and angle. All this is based, in turn, on the concept of space invented by Biagio Pelacani of Parma. The horizon line on which the vanishing point is located is a factor of the same space. It is simultaneously a visual experience and a dimension of measurement. In Arab art there is no need for a horizon that exists only in the eye of an observer, and in fact there cannot be one. In late book illumination the horizon is elevated, so as to spread the world out like a map and depict the view from above that only Allah can have.

Figure 7: Wall hanging from Bursa, Turkey, sixteenth century, Gulbenkian Museum, Lisbon (Fundacao Calouste Gulbenkian / Calouste Gulbenkian Foundation).

Geometry and Decorative Art: The Arabesque

The difference between the two cultures is repeated in the context of decorative art and craft in the East and West, although the initial situation was different. The barrier that normally separates crafts and decorative arts from works of art and figurative painting did not exist in either East or West before the Renaissance. Thus when Arab decoration became fashionable in the West there seemed to be no threshold to be crossed between East and West, only shared taste. After the Renaissance the decorative arts of the two cultures became so similar that it was sometimes difficult to tell them apart (and experts have occasionally had a hard time distinguishing Arab products from Venetian replicas or imitations), yet they never had the same significance. High art and decorative arts (as understood in the West) were not separated in Arab culture, as was the case in the West after the Renaissance conception of art was developed. Every implement used in daily life was ennobled through the use of geometric decoration, which represented a universally valid aesthetic of art undiminished by the functionality of the object. This provides an opportunity to reflect further on the two cultures' conception of art.

Once again it becomes evident how much East and West diverged in the defi-

nition of a picture. It is the definition of *picture* that acquires clear contours in the definition of *art.* When perspective was invented and came to define what is a picture in the modern period, a chasm opened up between "pure art" and "applied art," which did not attempt to reproduce nature but simply added decorative motifs. The concept of a picture was absent in the decorative arts in the West, too. With applied art, observers were not confronted with a gaze upon the world that was seeking to see pictures. Geometry here was not merely the scaffolding for a picture but its own currency or language of form. *Art,* on the other hand, became and has remained synonymous with *pictorial art* in the West from then on. It would have been inconceivable to give Arab geometry an independent status in perspective painting. It could play only a minor role, for example on carpets or other decorative objects serving as props in a picture, especially since it represented an exotic import.

The split between pictures and crafts was not complete in the West, but the exceptions do tend to prove the rule. Let us take a look at one such exception. A work entitled *Geometria et perspectiva* was published in Augsburg in the year 1567, a book that has no text and consists entirely of illustrations.[46] Already on the title page we find "several structures split open" that look like a set of toy buildings; their resemblance to ruins illustrates a geometrical manner of seeing (Fig. 8). Only the polygonal objects hanging or standing in the vaulted space represent pure geometry, yet they also relate to our gaze in their distance, height, and angle of vision. Human figures appear as well, who act on this stage for us only when they point to their eyes or to perspective views, while a dog is excluded from their perspective gaze. According to the author, Lorenz Stoer, the book was intended for cabinetmakers and intarsia craftsmen. And in fact intarsia work on doors and pieces of furniture was the only craft that adopted the painters' practice of making pictures and thus had need of perspective. One must take this special status seriously. Doors of cupboards and doors between rooms were pictures in a special sense. People approached them in the expectation that they would open like pictures, as if one could see through them into an adjacent room or the outside world.

Figure 8: Lorenz Stoer, Sketch for Geometria et perspectiva, 1567 (Staatliche Graphische Sammlung, Munich).

Pictures occasionally appeared on ceramics or porcelain as well, but these had to compete against geometrical and vegetal motifs that had become popular under the name of "arabesque." An excellent example of "representational" and "nonrepresentational" patterns as alternatives can be found in a handbook for potters published in 1559, *L'arte del vasaio* (The Craft of Pottery).[47] The word *arte* here does not mean "art" but is used in the older sense of "skill." Of interest is a full-

page woodcut that vividly depicts the two popular types of decoration in a split illustration (Fig. 9). The surface of a round plate is divided in two by a straight line, with an arabesque on the right half and a configuration of ancient trophies on the left. Here two worlds separated by the concept of the image collide. We have representational images only on the left, where a portrait of "Caesar Impera-

Figure 9: Cipriano Piccolpasso, L'arte del vasaio, 1559: Trophies and arabesques (Österreichische Nationalbibliothek).

tor" (the emperor Caesar) appears in the middle, surrounded by weapons, armor, and banners (the trophies of battle); they are distributed decoratively on the surface but remain quite representational and appear to be floating before a dark background that clearly suggests depth. The other half is entirely abstract because the scroll pattern is more geometrical than realistic, and the way it addresses the viewer is different as well. It is only in the case of the trophies that one can actually speak of a viewer who is standing in front of them and can relate the various figures to his gaze. In the other half the pattern is related to a horizontal axis of symmetry that in practice would have been doubled and reflected in a further axis to complete the decoration. This half is presented as an "arabesque." In the accompanying text one learns that the trophy designs were offered for sale in the pottery workshops of Urbino, while the arabesques were popular in Venice

and Genoa. In fact this design represents a Renaissance fashion together with an "Arab" fashion, as the term "arabesque" says.

The arabesque style bore its origins in its name and was sometimes equated with the *mauresque* or "Moorish" designs that had traveled by way of Spain. The term "damascene," referring to the city of Damascus, was usually applied to metal objects with decorative inlays, but the patterns used belonged to the general family of the arabesque. There is a wealth of literature on the arabesque in which scholars have only recently begun to resolve a number of old controversies. Currently experts believe that the strictly geometrical variety was fully developed in the East as early as the twelfth century. There it was known by the Persian term for knot *(girih)* and was thus a form of "knotted" style in which braiding and knotting characterize both the way the objects were made and the overall patterns.[48] Up to the thirteenth century the strict knotted style reigned alone; its geometrical patterns of interlaced bands were occasionally imitated in Venice.[49] There were as yet none of the flowers on stems or twining vines that would become so prevalent in arabesques.[50]

This new variant began to dominate from the thirteenth century onward, after the Mongols conquered the Arab world and the decorative arts were enriched with a Far Eastern vocabulary, including motifs from Chinese art and the newly flourishing genre of miniature painting. Plants and vines formed part of this vocabulary, but in Arab regions they were "translated," in a manner of speaking, into more geometrical shapes.[51] Only in this new balance of geometrical and representational forms, in which two eastern cultures met, did the arabesque become popular in the Renaissance, when it underwent yet another transformation. The older, purely geometrical variant was marginalized. Geometry now became the translation of vegetal scrolls into a surface pattern. From the early sixteenth century on, arabesque patterns spread through Italy in pattern books illustrated with woodcuts. They were intended for use as models or templates for embroidery and ceramics, that is, crafts practiced by artisans and women.[52] In a history of majolica from the eighteenth century the arabesque is mentioned as a method "for painting small flowers with numbers and also with braiding and knotting."[53] Already in the Renaissance, arabesques appeared in printed books, in the form of woodcuts as frames around a page of text; the first printed Koran was soon published in Venice as well.[54]

In the West the term "arabesque" was sometimes applied to all kinds of two-dimensional geometric decoration. In Islamic regions, however, the knotted style —from which the arabesque had developed—was a symbol and representation

of the world and thus art in the most general sense. Alhazen understood it as such in his work on optics (see p. 113). When the West turned the gaze into a geometric space, the scope for artists to use free geometry diminished. This restriction often stimulated the imagination of artists who were not content to make pictures alone. A kind of nostalgia developed that gripped even Dürer occasionally, who was otherwise known as an "enforcer" of perspective. In 1506 it appears that he was prompted by Italian copper engravings—a genre completely dominated by lines—to make a cycle of woodcuts in the knotted style, with the aim of outdoing the Italians with his dazzling technique. As he noted in the diary of his trip to the Netherlands, he later gave "the six knots," to a Dutch glass painter who could make use of them (Fig. 10).[55] He could offer them only as patterns for a craftsman, but it was not their practical application that had attracted him to the project; rather it was the free play of organic lines that he organized so as to create a hidden or embedded symbiosis of ornament and "figure" in the geometric sense. The woodcuts convey an impression that the artist has given free rein to a playful mood, enjoying the combinatory possibilities and his liberation from the requirements of representational images and three-dimensional space. What holds sway here is not the measurement of the human body that Dürer otherwise recommended so insistently to painters, but filling a surface with lines in many variations.

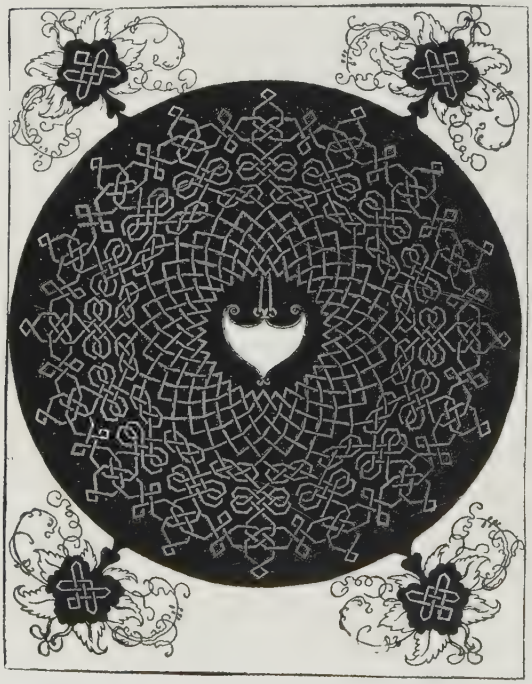


Figure 10: One of Albrecht Dürer's Six Knots, 1506, State Museums, Berlin (Bildarchiv Preussischer Kulturbesitz / Art Resource, New York).

It is possible that while he was in Venice Dürer saw and admired some Near Eastern bronze plates decorated with an almost inexhaustible wealth of filigree ornamentation, which are associated with the name of a Master Mahmud. Since these plates are signed in both Arabic and Latin, they were taken for a time to be Venetian copies. It now appears certain that they were produced in what is today northwestern Iran for export to the West. A particularly fine example is a Mamluk plate from the late fifteenth century, measuring twenty-nine centimeters in diameter, now in the British Museum in London. Four medallions bear the inscribed signature of Mahmud al-Kurdi and a plea for Allah's mercy (Fig. 11).[56]

Figure 11: Bronze tray by Mahmud al-Kurdi, end of the fifteenth century, British Museum, London (© The Trustees of the British Museum).

Over time artisans in Venice began to make imitations of such magnificent pieces in order to profit from the high prestige they enjoyed. It is clear that they served as trays in wealthy households or in the sphere of the church, and it is also clear that people admired the virtuosity of the craftsmanship, which was not tied to any principle of representation and open to a free aesthetic. The geometry is based on a mathematical calculation transformed into a filigree pattern that the eye must slowly "read," in a manner of speaking.

During the Renaissance it also became fashionable to use such nonrepresenta-

Figure 12: Cover of an edition of Virgil's works, Venice, ca. 1460, Harley Manuscript Collection, British Library, London (© The British Library Board).

tional geometry of Mamluk origin to decorate book bindings. Book dealers in Padua were the most important source for them. It thus came about that while the contents of a book might be derived from Greek or Roman antiquity, its leather binding could give it an Eastern appearance. Inside it might be filled with representational illustrations, while the outside featured an abstract geometrical design. This development began even before the invention of printing. A manuscript of the works of Virgil now in the British Library was produced in Venice and richly illustrated by the painter Cristoforo Cortese; later, around 1460, a binding was added with an arabesque pattern that makes it virtually indistinguishable from a contemporary Koran (Fig. 12).[57] Even experts were uncertain for a while whether it was a piece of Mamluk craftsmanship or a Venetian imitation. In this case the artisan and his repertoire of motifs speak with their own neutral voice.

The geographical and temporal proximity of representational fine art and decorative arts in the Renaissance places the two sorts of geometry they represent —in perspective and ornamentation—in even sharper relief. The West adopted Mamluk geometry only in crafts where the Renaissance concept of fine art did not apply. By then the definition of fine art was centered on representational works, which had focused on the gaze of an observer ever since the invention of perspective, with its geometrical grid of visual rays. After an excursion to two different aspects of Arab culture, this brings us back to the modern period and the topic of perspective in art.

The Globalization of Perspective

The globalization of perspective, supported today by Western-model television and press, has an astonishingly long history in the West's colonization of other

parts of the world and its missionary activities on behalf of Christianity. In this process perspective was virtually forced on people of other cultures, who had to give up their own established modes of seeing. When the Jesuits' mission in China showed the first signs of success, Father Matteo Ricci, who had arrived in 1583, extended the propagation of the faith to the propagation of science and technology in order to gain converts; he even added instruction in perspective drawing to the order's campaign.[58] The library founded by the Jesuits in Beijing soon contained nineteen books on perspective, including works by Daniele Barbaro of Venice and the Roman Jesuit Andrea Pozzo. Chinese visitors were unable to read the text in a foreign language but they were amazed by the unfamiliar realism of the illustrations and wondered whether the engravings were not actually some peculiar kind of sculpture, as they could not understand how figures seemed to step from the surface of the page. Father Ricci soon translated Euclid's *Geometry* into Chinese and praised his own native country, Italy, in the foreword for its schools of unequalled rigor, where research into natural phenomena was conducted with great success. Father Alessandro Valignano, Ricci's superior in Rome, at first urged him to train Chinese artists in linear perspective, but in the end Valignano changed his mind and shifted this training to Japan. There Father Giovanni Nicolao established the first workshops for instructing Japanese artists in perspective, between 1591 and 1614.

It took until the eighteenth century, however, for perspective to catch on in Japan. Shiba Kōkan (1747–1818), who learned about Western art at the Dutch trade mission in Nagasaki, wrote then that there was only one "correct way of seeing"; the reason why Western pictures were framed and hung on the wall was so that they could be viewed properly. In order to examine them even briefly, it was necessary to stand directly in front of them and to make certain that the horizon line dividing the earth and sky was precisely at eye level. Viewers should also try to look at a picture from the right distance. "If these rules are followed, such a picture will be indistinguishable from reality."[59] Perspective pictures became known as *ukiyo-e,* "pictures of the floating world," or *kubomi-e,* "sunken pictures." Apparently Japanese viewers had the impression that their gaze either "flowed" into the picture or "sank" into a make-believe concave space.[60] Some painters hit upon a compromise, in which they limited the new fashion to parts of a picture but retained the Japanese mode of seeing in the rest.

Western perspective encountered the least resistance in the Japanese mass media, whose prints did not count as high art. For the most part Western pictures were used for prints, so Japanese artists went on painting in the traditional manner for the elite, while the media served up Western-style "news" images to the

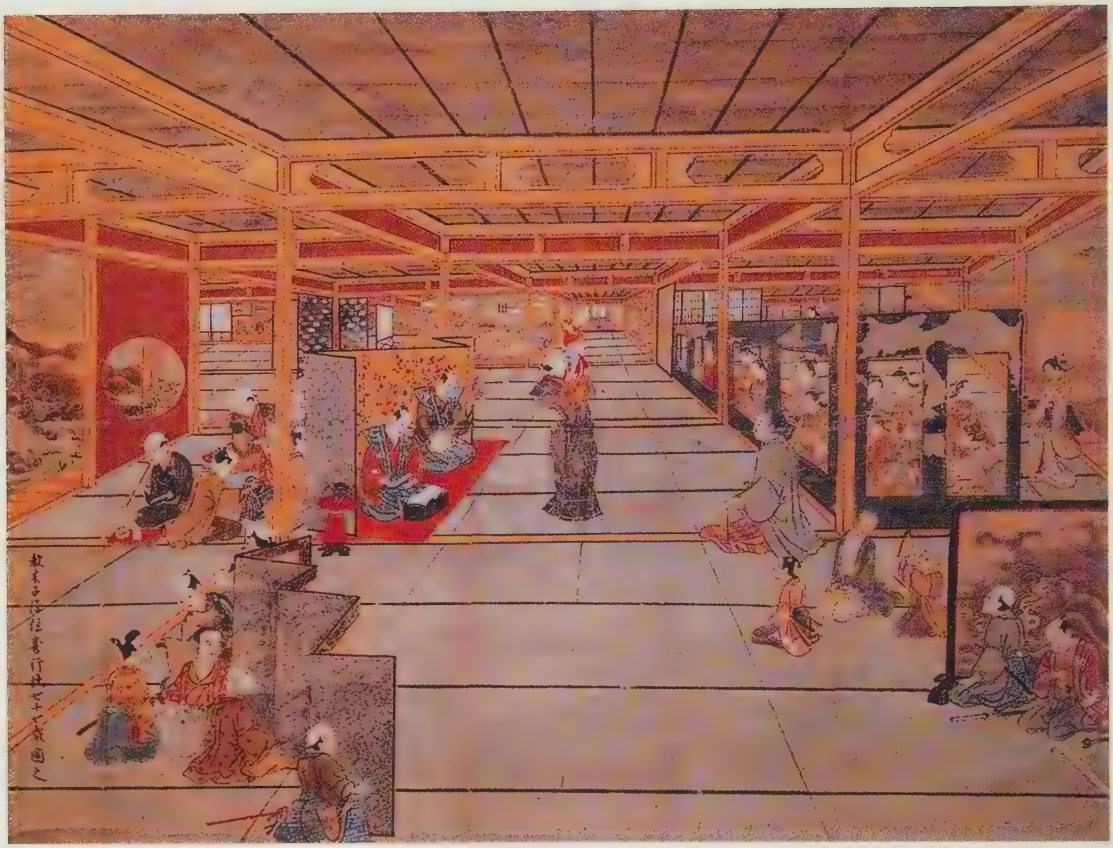


Figure 13: Puppet Show in a Teahouse, hanging scroll, Japan, eighteenth century (National Museum, Warsaw).

general public. Peep-show boxes defined the public's conception of perspective images. In the West they were also known as *vues d'optique* from the French term *optique,* for the viewing box that held the image (in English, "zograscope"; German, *Guckkasten*). In Japan they were largely identical with *ukiyo-e.* Occasionally perspective representations of early Japanese woodcuts are found on hanging scrolls, such as the one here by a seventy-seven-year-old artist who "painted this scene in the autumn of his life" (Fig. 13).[61] The scene shows a teahouse with its doors opened to the outside, painted strictly according to the rules of perspective, in which a puppet show is being performed for an audience sitting between screens. It is striking how little effort has been made to integrate the human figures into the perspective construction. This shows that the artist regarded painting architecture in perspective as a special task that did not necessarily require an understanding of the whole painting as a geometrical rendering of space.

In India perspective drawing became a permanent component of colonial re-education. Lockwood Kipling, father of the writer Rudyard Kipling, began teaching at the School of Art and Industry in Bombay in 1865; the school's name reflected Britain's new interest in training young people in design. The elder Kipling regarded Indians as incapable of producing art in the Western sense, but Sir Richard Temple, his superior in the colonial administration, insisted on a strict course in Western art. According to him the students were supposed to learn what they had never learned in all the preceding centuries, namely to draw things "correctly." Such instruction would help them overcome their "mental faults" and direct their attention to the "glories of nature," of which they were so fond.[62] Despite the use of carrot and stick, however, resistance to perspective lived on. At the same time that colonizers were endeavoring to change modes of seeing, early photographers in India were refusing to adopt the Western perspective code, preferring instead to compose their pictures according to the tradition of Indian painting.[63] There can be no doubt that perspective functioned as an instrument of colonialism. Europeans considered it the "natural" way of seeing, and thought such realism was a demonstration of the progress that would bring the blessings of the modern world to the colonies.

A remarkable countermovement developed in modern art as, on the one hand, European realism was introduced in Asian culture and, on the other, Western artists developed a great affinity for the free "subjectivism" and gestural creativity of brush and ink painting in Asian art. The Japanese woodcut with its unfamiliar perspective, seemingly naive and hence so expressive, was received with great enthusiasm in the Paris art scene. Vincent van Gogh, who had dealt in Japanese woodcuts in the 1880s to eke out a living, soon began to render prints like Hiroshige's *Bridge in the Rain* as oil paintings.[64] An aesthetic revolt was brewing, as artists sought to free themselves from the irksome legacy of academic perspective. Just as the Japanese were even beginning to import oil paintings from the West, the influence was going in the other direction in Parisian art circles as painters encountered traditional Japanese art. Van Gogh had never been to Japan, but he read all the books about the country he could find, and in Arles in the south of France he dreamed of an imaginary Japan as the home of artistic freedom.

This contradictory dialogue with Asia is recapitulated today in the Chinese literature on art, with a certain degree of self-criticism. The Chinese critic Li Xiang Ting, for example, a spokesman for the post-1980 avant-garde, has argued that when Western realism was introduced in the late nineteenth century many

Chinese regarded it erroneously as a movement that would rescue Chinese art. "One can almost characterize the exchange that took place as an antinomy," he says, "since the art of each culture was seeking a contrary current in the other and embraced it." While the West learned to appreciate the "subjective freedom" of Chinese art as a protection from "compulsory realism," "the East, where this expressive freedom had always been at home, dutifully adopted the rules of objective representation."[65] In this exchange the understanding of modernity that dominated in each place underwent a shift. As Western art discarded the tired clichés of its realistic imagery, the Far East welcomed realism as an emblem of modern times.

In the modern period perspective has had to reckon with resistance from believers in Islamic regions. The issue was realistic pictures; for the general public it involved their religious identity, and such pictures were still associated with a taboo. As a result they easily became a symbol of modernity about which public opinion was divided. So long as realism was the depiction of a contemporary world and perspective was its battle cry, there was inevitably going to be a dispute about whether to tolerate or reject it, even if the price of rejection would be an accusation of backwardness. But perspective also became a hallmark of new technologies when it was applied to documentation, architectural drafting, and strategic warfare. Particularly in the field of technical drawing, the issue of pictures left very little leeway. The Ottoman Empire was not a colony of the West, but in the process of modernizing—if one wanted to see the world with modern eyes—it found itself confronted with colonial problems. A paradoxical situation arose as a corollary: As "orientalism" flourished in Western art as a kind of colony of dreams, [one part of] the East had no pictures of itself because it did not depict the world in pictures.

Perspective would not prevail in the Middle East until it began to be taught in local academies of art, but these did not exist for most of the nineteenth century. A school of this kind was first founded in Istanbul in 1881, and in Cairo only in 1908. The founder of the academy in Egypt was a Frenchman, Guillaume Laplagne, who faced resistance that included a written protest against the Westernization of Muslim art.[66] The art historian Celal Esad (1875–1971) of the academy in Istanbul stated that he saw Western art for the first time there.[67] Perspective drawing was also being taught at military academies in connection with strategy and weapons technology; there it was not a matter of art but of survival. The Ottoman diplomat and art collector Halil Şerif Paşa (1831–1879) had proposed to the government that it should make the Egyptian military academy in Paris the model

for schools in the Ottoman Empire. He was, incidentally, the first Muslim to collect paintings by the Parisian avant-garde. He also may have met the first three Turks who studied art in Paris in the 1860s. When they returned to Istanbul they were forced to take up posts in elementary schools or at the medical school, where they could teach anatomy. One of them was the painter Osman Hamdi (1842–1910), the first artist to depict scenes of his Ottoman environment. Hamdi founded the Istanbul Academy of Fine Arts and served as first director of the Imperial Museum (now the Istanbul Archaeology Museums).[68]

An early reform movement at the end of the eighteenth century had introduced Western art at the court of the sultan there. It appeared as rococo ornamentation on the walls and in the form of landscape paintings, in which it was possible to dispense with human figures. The French writer Gérard de Nerval mentioned this decor when he visited Istanbul on his travels to the East in 1843.[69] Depictions of combat at sea were also popular at the court, Nerval observed, "because they did not need any people in them" and ships alone were sufficient. "In the foreground enormous fish were swimming," apparently not disturbed in the least by the battle raging just behind them. In general, according to Nerval, the Turks had "no painting, at least not in our sense of the word." He did come across paintings for sale at stalls on the Galata Bridge, but most of them were views of Mecca from a bird's-eye perspective. Nerval was aware, however, that wealthy families in Istanbul secretly employed foreign painters and even commissioned portraits, although portraits in painted form had recently been declared the exclusive privilege of the sultan. Collectors of art usually limited themselves to permitted themes; a story survives about one, however, who owned a portrait of himself but on learning that he did not have long to live hastily gave it away to a European. In his book on Istanbul, Orhan Pamuk voices his belief that his fellow writer Nerval disparaged everything he saw there. Nevertheless the title of Pamuk's novel *My Name Is Red* may have been inspired by an anecdote that Nerval relates: One day a French artist named Camille Rogier, who spoke Turkish, came upon a Turk sitting in front of the Bayezid Mosque, making a drawing of it. The man was obviously highly skilled, but he had made the minarets of the mosque red instead of white, "as they are in reality." When Rogier asked why, the Turkish artist replied that the work had been commissioned by a high-ranking military officer "who loves the color red and asked me to use it in the picture. Everyone has a favorite color, and I try to please every taste."[70] The anecdote may be invented, but it perfectly sums up the issue of realism and the related topic of perspective.

Blickwechsel: Orhan Pamuk and Perspective as a "Betrayal"

As noted before, a section called *Blickwechsel* ("Shifting Focus") will stand at the end of each chapter. Here an obvious subject is the Ottoman Empire, which has already been mentioned in the context of globalization. In that context we were concerned with modernization; here we will focus on two other topics. Long before the modern period, the Ottoman Empire was the first region in the Islamic world to come in contact with Western art. Venetian artists brought the cultural technique of perspective to the court in Istanbul only a few decades after its invention. Even though this first contact was limited to a brief episode, it deserves attention, as does the period of the painter Nakkaş Osman a hundred years later. Once again Orhan Pamuk will accompany us on our excursion.

Sultan Mehmed II, who conquered the thousand-year-old city of Constantinople in 1453, basked in the glory of the imperial capital of the Eastern Roman or Byzantine Empire. A few decades after his victory he envisioned opening his court to Western art. The project came to an end after only two years, however, when the sultan died in 1481 and was succeeded by his devout son. Although the arabesque style encountered no resistance worth mentioning in the West, the Western concept of a picture—epitomized by the panel painting, particularly the individual portrait—led to conflict at the Ottoman court that could end only in rejection of the Renaissance. Soon the dream of peaceful coexistence was over, even in the area of culture. The Ottomans kept moving their front line in the Balkans further and further to the west, and by the sixteenth century they had reached the outskirts of Vienna for the first time. In its defense the West mobilized its religion to help decide the struggle. Icons were used against the "heathen" enemy, who were also accused of defiling religious images, as the Jews had been before them.

Since there was no literature on art in the Western sense in the Ottoman Empire, very few reports about encounters with Western art have survived. Orhan Pamuk has filled this gap with a piece of fiction—but one so plausible and based on so much knowledge that we can take his novel as a source of inspiration. *My Name Is Red,* already mentioned above, deals with the "betrayal" of Turkish painters who secretly learned the perspective technique of the "infidel Frankish masters." A murder is committed to prevent exposure of this betrayal, which would

bring down the wrath of strict believers.[71] Of course Orhan Pamuk's theme is repression and the enforced practice of religion by a fundamentalist majority. But he illustrates it through the example of linear perspective, which violated a taboo by inviting people to look at forbidden images. While Islamic painting drew a horizon line and depicted the world from an elevated God-like position, the innovators looked at it from "the simple perspective of a mutt."[72] Thus they painted a mosque the size of a horsefly because it was farther away. The victim provoked his own murder by stating that painting pictures with the art of perspective was Satan's work. If someone removed a painting from Allah's vantage point and lowered it to that of a dog in the street, then he would lose his purity and become a slave of the infidels.

Painted portraits—which depicted an arbitrary gaze, as did, in a more general sense, the perspective technique of which it made use—were also taboo. As panel paintings hung on a wall they demanded that an observer face them directly and meet the gaze of a lifeless image, a random subject. When a reader bent over a book different conditions applied, so the sultan—but he alone—could be depicted and made recognizable by his clothing and attributes. In Pamuk's novel the figure Kara hears his uncle describe with horror the portraits he had seen as a diplomatic envoy in Venice. They depicted a variety of individual faces, all different from one another, unique. The painters had granted them a kind of magic with which they tried to intimidate him. A fondness for portraits, the uncle said, would bring about the end of Islamic painting.

The first portrait of this kind at the Ottoman court was painted by a Venetian artist. It bears the date November 25, 1480, when its creator, Gentile Bellini, was in Istanbul as the guest of Mehmed II. As a panel painting, the work—now in London—was out of place at the sultan's court, and this may have been the reason why it did not remain in the palace collection in the seraglio (Fig. 14).[73] It makes no compromises with the practice of book illustration, but even as a physical object it is an out-and-out embodiment of the perspective technique that belongs more in Venice than Istanbul. When the Ottoman Empire signed a peace treaty with Venice on the Feast of St. Mark in 1479, an envoy of the sultan's had conveyed his request for "a good artist who is skilled in painting portraits," as Malipiero reported in his contemporary annals. Although Bellini was under commission to produce works for the government of Venice, he was dispatched to the Ottoman court and not only produced the painted portrait of the sultan but also a commemorative medal bearing his image. The sultan rewarded him with a knighthood.[74]

Figure 14: Gentile Bellini, portrait of Sultan Mehmed II, 1480, oil on canvas (© National Gallery, London / Art Resource, New York).

Figure 15: Şiblizâde Ahmed (?), Sultan Mehmed II smelling a rose, ca. 1480, watercolor on paper (Topkapi Palace Museum, Istanbul).

Bellini's portrait seems to have inspired two further depictions of Mehmed II in an album formerly in the palace art collection. These were made in watercolor on paper and as such represent a return to local practice. For a time they were attributed to the painter Costanzo da Ferrara, who was active in Istanbul as early as 1467, but now they are usually considered to be modeled on Western art technique but painted by a Turkish artist or artists. One of them follows the European convention of the head-and-shoulders portrait, while the other shows the sultan in an artistically hybrid form, sitting cross-legged and smelling a rose (Fig. 15).[75]

Bellini himself sketched a Turkish painter (or was he a scribe?) in a gouache on parchment that must have caused a sensation in local artistic circles. It shows Bellini's young colleague sitting cross-legged and bent over a sheet of paper on a tablet on which he is working with full concentration (Fig. 16). The picture represents a departure from two norms: both from the conventions of Ottoman art and from Bellini's own style. In the first instance it does not portray a sultan but a craftsman, and instead of following the conventions of the seated pose it catches the

subject in a spontaneous and natural attitude. And in the second instance it does not fit into either of Bellini's usual genres, being neither an oil painting nor an uncolored sketch. In its use of colors it clearly echoes Ottoman works on paper but without imitating their style. The young Turk is serving as a model for a Western gaze.

This small work (18 × 14 cm) was already a sought-after collector's item and unique in the Middle East when a notation in Arabic was added on the back, stating that it was "the work of Ibn Muazzin, one of the famous Frankish masters."[76] A short time later Bellini had departed from Istanbul and the sultan was dead. His son Bayezid II (ruled 1481–1512) brusquely ended the flirtation with Renaissance art and rid the palace collection of the works his father had acquired. When war broke out with the Republic of Venice again, he had all the Venetians in Istanbul arrested and imprisoned.[77]

Orhan Pamuk alludes explicitly to events that took place at the Ottoman court almost a hundred years later, as the names of the "incomparable" court painter Nakkaş Osman and the author Seyyid Lokman attest. The two men collaborated on a volume designed to celebrate the ruling dynasty, from its founder, Osman I, to the ruling sultan, Murad III (ruled 1574–1595), who was a patron of art and a book lover. One of the main themes of this monumental work was physiognomy as a study of character. The issue of the portrait then became unavoidable, although they still could not create Western panel paintings to be hung on a wall. As far as I can tell, perspective did not stand at the center of the various controversies, yet the renewed encounter with the Italian Renaissance gave rise to a new surge of Islamist sentiment that merits brief examination.[78]

This episode is well documented in contemporary sources and took place in the years 1578 and 1579. At that time the court painter Osman approached Grand Vizier Sokollu Mehmed Pasha with a request: Since they had no reliable portraits of earlier sultans and their appearance was not well recorded, Osman wanted to acquire paintings by Western artists. The grand vizier assigned this task to the Venetian envoy, who sent an urgent appeal to his government to supply such portraits as soon as possible. The grand vizier specified that they should be oil paintings, as they were more lifelike than the usual woodcuts produced by Western printers, with which he was familiar. A year later a series of such portraits arrived in Istanbul. They are identified today with a cycle of paintings from the workshop of Paolo Veronese, and while only a few of them have been preserved in Istanbul, there is an alternate complete set in Munich. The set in-

cludes a lively portrait of Selim II (ruled 1566–1574), the predecessor of the reigning sultan (Fig. 17).[79]

These portraits were obviously either based on unreliable earlier paintings or complete fabrications, since it was hardly possible to determine any longer what the sultans of the fifteenth century had looked like. What the portraits reveal is thus the skill of Venetian portrait painters in conjuring up a lifelike impression even when they had very little to go on. The likenesses they worked from went back, in turn, to a series of miniatures by the Turkish artist Haydar Reis (also known by the pseudonym Nagari) that a Turkish admiral had presented to the Republic of Venice in 1543. The historian Paolo Giovio had woodcut copies made of them for his great work on war heroes, published in Basel in 1575, and the grand vizier clearly had a copy of this book available to him when he requested artwork of a higher quality from Venice. No doubt the portrait of Selim II possessed greater authenticity than the others, since everyone at court could remember him and by that time there were enough Western painters living in Istanbul who could convey a sense of his appearance.

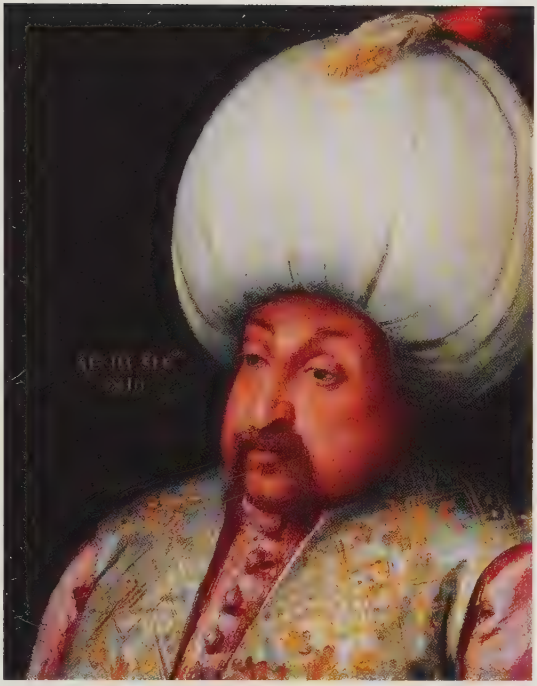


Figure 17: School of Veronese, Sultan Selim II, last quarter of the sixteenth century, oil on canvas, Alte Pinakothek, Munich [© Bayer & Mitko / ARTOTHEK].

When the court painter Osman included Selim II in the series of twelve miniature portraits of sultans for the planned book on their physiognomy and character, he had no need of a Western likeness to copy, since he had known Selim II personally. He may have consulted the painting from the Veronese workshop, however, to make sure that his own likeness of the sultan was sufficiently different. Osman's sultan has none of the plump softness of the Venetian series but is rather a man of powerful physique, shown facing the viewer with an alert, intense, and watchful look about him (Fig. 18). (A further factor that may account for the difference is that the paintings from Venice arrived too late, only a few weeks before the completion of the great book project and the assassination of the grand vizier in October 1579. Osman did not have much time to consult them.) Osman's work was of course a miniature intended for inclusion in a book, and as we can see, it shows the sultan seated cross-legged. He would have consulted the Western portrait solely for the facial features; his conception of the portrait as a

Figure 16: Gentile Bellini, sketch of a Turkish painter or scribe, ca. 1479–80, pen and gouache on parchment (Isabella Stewart Gardner Museum, Boston).

Figure 18: Nakkaş Osman, miniature of Sultan Selim II from the treatise on physiognomy Şemâ'ilnâme, 1579 (Topkapi Palace Museum, Istanbul / photo Hadiye Cangokce).

whole was inspired by completely different ideals. Osman's likeness of the sultan was intended to complement Lokman's text. The character of the sultan would have been established by using iconography comprehensible only to members of the court and by linking his name to illustrious predecessors.

It should be stressed once more that what divides the two portraits is perspective. The Venetian artist did not use any perspective symbols as such, but he took perspective for granted in the evocation of three-dimensional space and a light source from one side. What distinguishes Osman's portrait is the fact that it was painted by someone who was familiar with perspective but consciously adopted a contrary strategy designed to exploit a two-dimensional surface. His choice of colors makes a particularly strong statement. The colors enhance the ornamentation, which develops its own expressive energy; between the sultan's sumptuous robes and the background, patterns cover the entire miniature with bright surfaces. Osman's conception, which contains a renunciation of Western realism, left its stamp on Ottoman portrait painting for the next two centuries. So far as his book project was concerned, "verisimilitude" was a catchword that could only lead to controversy in speaking with Venetians. And there was a further delicate matter, namely the fact that the author of the text maintained that his physiognomy was "scientific," and wanted to see this confirmed by Osman's portraits. He was relying on a doctrine that dated from antiquity and was popular in the West even before the early modern portrait was invented, that cited such features as an "eagle eye" and the "nature of a lion." And Osman's portrait needed to "tell a story" just like Lokman's text, which readers would have alongside the picture when they opened the book (see Chapter 2, in "Under the Gaze of Allah"). Otherwise they would have felt themselves in the presence of an "idol" that had taken the place of the real person.

2

The Taming of the Eye

Criticism of Seeing in Islam

Religion and the Prohibition of Images

In recent years there has been a great deal of controversy about what the term "prohibition of images" really means in Islam. A new dispute has broken out among scholars about whether figurative representations have ever existed in Arab culture, and if so, where and when.[1] As we have seen, this argument cannot be just about the modern period, since during the nineteenth century pictures prevailed in the Ottoman Empire despite stubborn resistance (see p. 46). The recent clash with the West that arose over newspaper cartoons involves different questions, namely, how images of the Islamic religion and Muhammad are to be treated and whether Islam itself ever employed them. Diverse arguments and ideological claims play a role, many of which have little to do with historical facts.[2] In the context of this study, however, we are concerned with the fact that when we look back at history, the conception of what a picture is divided the West from the Arab world even before the modern period. This difference culminated in the invention of perspective and its essential tie to the gaze of an observer. The way these two are bound together places the Western conception in sharp contrast to the restrictive controls placed on the gaze in many Islamic societies.

Two examples may suffice as an introduction. In the Aya Sofya, or Hagia Sophia, in Istanbul, the former church that is now a museum, visitors can see Byzantine mosaics that were plastered over for centuries. These Christian images were uncovered the first time by Sultan Abdülmecid I (ruled 1839–1861), an advocate of reform, when the building was still a mosque. That was in 1847, and the story is told that when the sultan saw them he exclaimed: "How beautiful they are! But we must plaster them over again, since our religion forbids them." He hoped that a future era might be more tolerant, so that the images could be exposed once more. In the meantime he had large medallions with Arabic inscriptions made

Figure 19: Souvenir stand in Istanbul, 2007 (Hans Belting).

and hung on interior columns.[3] Today there is a souvenir stand in front of the same building displaying evidence of a divided world (Fig. 19). Western tourists can buy reproductions of icons and mosaics from the former church, while Muslims are offered calligraphic excerpts from the Koran as a souvenir of their pilgrimage. I imagine few visitors of either faith will be in doubt about which to choose.

In the debate over the prohibition of pictures in Islam, one group claims that it was total, while another portrays it, with the same degree of exaggeration, as pure legend. Even if there was no general prohibition of pictures in the Islamic world, least of all in Shiite Islam, the existence of a taboo against anthropomorphic images and especially three-dimensional images in the area of religion cannot be doubted. Other conditions applied from the thirteenth century on at courts of Muslim rulers, but only for books in which pictures were subordinate to the text. Panel paintings hung on walls, which a viewer might confuse with a living being, remained taboo. Not only was it forbidden to paint them, it was also a sin just to

look at them. In gazing at them, it was feared, an observer might take portraits to be real creatures. The traditions handed down from the time of Muhammad and gathered into various collections base the ban on the argument that such paintings counterfeit life. Hence both those who produce them and those who own them are guilty of the sin of forging God's creation, a form of blasphemy.[4]

In Islam the prohibition of pictures is a separate question from *iconoclasm.* Once the Islamic religion was fully developed and the conflicts with Christian minorities had ended, there was usually no cause to smash images. By that time Arabic culture was nonpictorial. There were local and limited measures against Christians already living under Arab rule, whose religious images gave offense. In a similar manner—although with the roles reversed—Jews, whose religion permitted no images, were the targets of aggression in Christian society. It is not difficult to recognize the causes in both cases, since images touched directly on the identity of the dominant religion. The figure of Jesus played a key role. Jews did not recognize Jesus as divine and continued to wait for the coming of the Messiah, nor did they recognize Muhammad's teachings as the revealed word of God. Christians came under suspicion of polytheism by Muslims because they ascribed a divine nature to Jesus and took him to be the "Word of God" made flesh. The issue of pictures was a sensitive one in this last respect, since God could be depicted in Jesus only if one believed that Jesus had a "share" in the divine nature, as Islamic sources put it. From the Islamic perspective, Christian monotheism looked like a disguised form of polytheism.

The prohibition of pictures is an expression of the Islamic religion in a double sense. First, it keeps alive the memory of how Muhammad defeated pre-Islamic tribal culture in the region around Mecca: He insisted on monotheism and "cleansed" the tribes' religious sites of their images and symbols. Anyone who reverted to using images like those prevalent before Muhammad's revelation identified himself as a nonbeliever. We can speak of an iconoclastic founding act of the faith when Muhammad circled the Kaaba and destroyed the tribes' idols, which were set up there and each worshipped on one day of the year. The black meteorite of the Kaaba was an ancient object of veneration. According to Islamic tradition, Abraham built the Kaaba on the spot where his son Ishmael had departed into exile. The practice of circumambulating the Kaaba continues today, but at the time of Muhammad's cleansing its appearance changed. The new absence of images also created a link back to the religion of Abraham; the Koran relates that Abraham performed similar acts of smashing idols (sura 21.58). When Muhammad declared the arrival of truth in the name of religion (Islam), the "days of ig-

norance" *(jahiliyyah)* and of idols came to an end (sura 17.81).[5] Today Mecca's appearance reflects a further act of force: In 1803 the Wahhabis, under Saudi leadership, laid waste to the city and destroyed the interior of the great mosque, shrines, and tombs; a year later they even attacked the tomb of the prophet in Medina.[6]

The second sense in which the prohibition of images expresses a fundamental aspect of Islam involves the key role it played in differentiating the newer religion from Christianity. If Jesus was only a prophet and thus a human being, then veneration of his image qualified as worshipping an idol, since in that case depicting him was *unworthy.* But if he was God, then in a monotheistic religion He had to be invisible, and depicting Him was *impossible.* The theological debate grew more intense after Muawiyah I, the first caliph of the Umayyad dynasty, took up residence in Damascus in 661 and waged war again the neighboring Christian empire of Byzantium. Sunnis, whose name means "people of the tradition," established their rule over most of the Middle East, while the Shiites broke away. The war against Byzantium, where images were venerated, politicized the issue of religion, resulting in the repression of Christians who lived under Islamic rule. Any compromise with the local Christians was seen to pose a risk for the dominant faith.

One of the Christians living in this environment so hostile to pictures was the famous John of Damascus (ca. 675–749), who was later to become the most passionate defender of holy images in the Eastern Church. Both his father and grandfather had held high offices at court, and John followed them in this profession until the accession of the very pious Umar II (ruled 717–720) altered the atmosphere of the court and he was forced to resign. Arab domination of the civil service left no room for a Greek Christian. John withdrew to the Greek monastery of St. Sabas near Jerusalem, where he spent decades writing polemics in defense of images in the Christian faith.[7] Walid I confiscated the Basilica of St. John the Baptist in his capital, Damascus, and converted it into a mosque. When the seat of the Greek patriarch of Jerusalem was filled after it had remained vacant for a long time, Walid II had the new appointee killed, turning him into a martyr. Peaceful coexistence with the "peoples of the book," as Muslims referred to Jews and Christians, was breaking down.

The theology of images that John of Damascus propagated was directed at Byzantium, however, where for several decades, beginning in 730, the leaders of the church adopted Islam's antagonism toward pictures. By giving up images they

also abandoned the most visible feature separating the church from Islam. The Christian teaching of the incarnation could be confirmed by images of God become flesh. John, who refers to Islam as the "religion of the Ishmaelites," carries on his own polemic against the still relatively new faith in his works *Concerning Heresy* and the *Disputation between a Saracen and a Christian.* He defends Christians against the charge that they are idolators because they prostrate themselves before the cross. The Koran does in fact reject the tradition that Jesus died on the cross. John of Damascus in turn accuses Muslims of venerating the Black Stone of Mecca, which he says "is a head of . . . Aphrodite . . . Even to the present day, traces of the carving *(enklyphidos aposkiasma)* are visible on it to careful observers."[8] John makes the controversy over Jesus the focus of both texts. If even the Koran "says that Christ is the Word of God and His Spirit," he argues, then Jesus must share the divine nature and be more than purely human.[9] John of Damascus taught that from the incarnation of the Word followed the legitimacy of its depiction. Illustrations or images of Jesus did not occur in his texts—probably from motives of caution—but they must have been a major point of contention in discussions. The outward appearance of the two religions was stamped by this key difference on the question of God; both Jewish tradition and the Koran rejected the idea that God had become visible in the person of Jesus.

When John of Damascus wrote his texts, conflicts over the images that Christians used were common. The first one broke out under the caliph Abd al-Malik (ruled 685–705). His brother, the governor in Egypt, had campaigned against the Christians there because of their religious images. Christians said that the governor died as a result of having spit on an image of the Virgin in a Coptic monastery. He had publicly exposed the Christian images by asking: "Who is this Christ, that you worship him like a God?"—a question that perfectly summed up the contrasting positions of the two religions.[10] Because the issues surrounding Jesus and Muhammad had not yet been definitely settled, they remained sensitive in Muslim regions. A Coptic monk named Severus, who reported on these occurrences, also mentions the caliph Yazid II and his promulgation of an iconoclastic edict in the year 721. Since he "had crosses destroyed and the pictures in churches eradicated," he was struck dead immediately. It appears that Yazid II did in fact order the destruction of idols *(asnâm)* and statues in Egypt. His successor, Walid II, did not revoke the edict and even increased the repression of Christian communities.[11]

The establishment of an aniconic culture meant the complete abandonment of

all Mediterranean traditions of imagery in the former Roman Empire. The minting of coins under the same Abd al-Malik, whom we have just encountered in conflict with Christians, reflects this transition. He had his coins inscribed with the phrases "ruler of the orthodox" and "representative [caliph] of Allah." Such a manifesto prompted his neighbors in Byzantium to choose "orthodoxy" as another ideological weapon in the conflict between the two systems. The Byzantine emperor had *his* coins struck with the title "servant of Christ," a rejection of the caliph's claim to be "God's representative." It was the strongest possible reply to an assertion of rule in the name of Allah when the emperor named Jesus in God's stead. Up to that time traditional Islamic coins had borne a portrait of the ruler, but these were replaced—on gold coins in 695 and on silver coins in 698—by Arabic inscriptions that invoked the sole God by name and affirmed the mission of Islam. In this way the caliphs countered the icons of Christ that had been introduced so prominently on Byzantine coins.[12] Christ, the "Word of God" made flesh, was in their eyes a provocation against Allah, the sole God.

Islam's aniconic representation of itself also emerges in the architecture of the Umayyad dynasty after Muawiyah, the first Umayyad caliph, seized power. Up to that time, in places such as the Dome of the Rock in Jerusalem and the Great Mosque of Damascus, the adornment of the walls still followed the Mediterranean tradition of late antiquity, since this was the style in which the craftsmen who also worked for the Islamic court had been trained. But under Muawiyah a complete break with this precedent occurred: all human figures were eliminated, to be replaced by vegetal decor or abstract ornament. All that remained from the former church decoration was an empty gold surface. This provided the background for a new, nonrepresentational kind of art.[13] The writing that now became an integral part of the wall mosaics had no precedent in that function in the Greco-Roman world. This act transformed nonpictorial decor into an instrument of the new faith.

The Dome of the Rock, which stands on the site of the former Temple in Jerusalem, was the most ambitious project of the same Abd al-Malik who altered the appearance of coins. An inscription commemorating its founding extends around the inner arcade for a length 240 meters and refers to the year 692 (Fig. 20). It contains the earliest datable quotations from the Koran, including a profession of faith: "The religion before God Is Islam" (sura 3.19).[14] There are also repeated references to sura 17.111: "Praise be to God, who begets no son, and has no partner in his dominion." The people of the book are addressed directly and told to tell the truth about God. "Jesus, son of Mary, was only a messenger of God" and not one

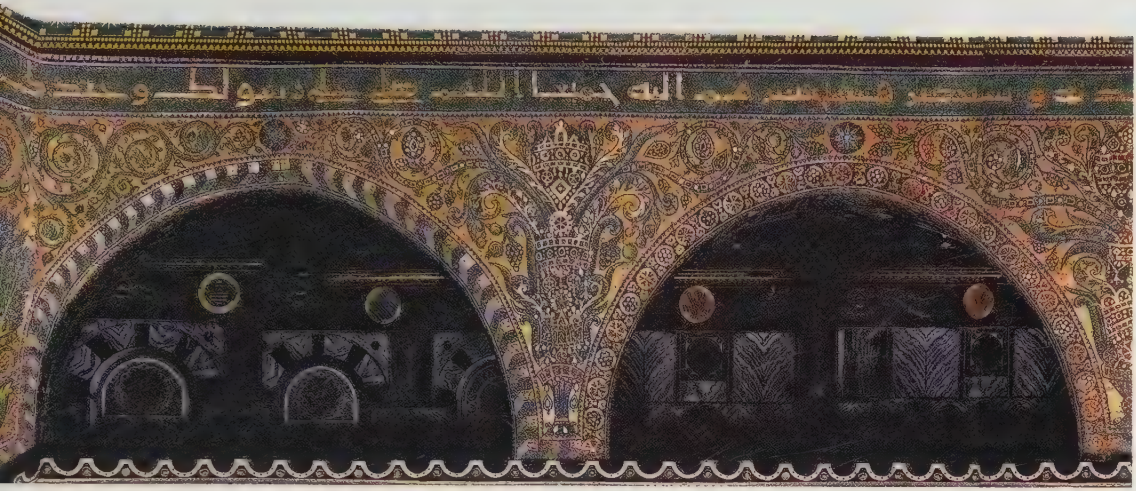


Figure 20: Dome of the Rock, Jerusalem: Mosaics in the inner octagonal arcade, ca. 700 CE (Said Nuseibeh Photography).

of three persons in the Godhead, for "God is only One God." The faithful must defend God against all the false claims of polytheists.

The monumental textual inscription in the Dome's magnificent interior, adorned with gold mosaics and marble, proclaims an agenda; the absence of representational images has become a program. Such sumptuous decoration is familiar from Christian churches, but here visitors enter a site dedicated to the invisible God, whose presence is indicated all the more forcefully by the absence of anthropomorphic depictions. Imagery and decor are two separate entities: The decoration that was retained was intended to cleanse the senses and direct visitors' thoughts to the One who cannot be seen. The repertoire of late antiquity is the source of the motifs, but they are limited here to vases and plants (Fig. 21). In this revision the vine scrolls turn seamlessly into inorganic bands of gold and gems, or sprout from vases made of the same substance. Only a few palms depicted with hanging fruit have kept their natural outline. In the texts of the Hadith we will encounter the view that trees and other plants are not living creatures and thus do not fall into the category of proscribed images. They have been frozen and incorporated into the strict pattern of the surface in such a way as to anticipate the dematerialization of all forms that would come to dominate Islamic art in the following period (See p. 115). One must have stood in this empty interior flooded with light and marveled at the enormous surfaces it covers, to grasp how the seemingly infinite repetition demolishes all boundaries.

Figure 21: Dome of the Rock, Jerusalem: Mosaics under the dome, ca. 700 CE; the inscription notes a restoration in 1027–28 CE (Said Nuseibeh Photography).

Images as a Betrayal of the Living Creation

The prohibition of images in Islam had acquired a significance that can be explained in terms of the new religion's self-understanding. It had to compete in a world in which the pictorial culture of antiquity was rooted in Christianity, but it also had to assert itself vis-à-vis Judaism, which had been appropriated by Christianity as its own heritage. From the Islamic point of view the new revelation of the Koran not only fulfilled the salvific history of Judaism and Christianity but

also transcended it. Islam could achieve recognition, however, only if it protected itself from every form of syncretism and strengthened the boundaries separating it from other religions. The images employed in Christianity posed a threat for this very reason. They could only contaminate the purity of a revelation that banned any attempt to invoke God's presence through anthropomorphic depictions.

One question that arises all the more forcefully is why, in that case, does the Koran not contain any mention of images, and the answer lies in the circumstances under which the text originated. The original context of the Koran was neither Rome nor Byzantium but rather the tribal culture native to Arabia, whose idols had already been defeated. The Koran does not appear even to reckon with the possibility that pictures or statues could ever pose a serious threat to its message. Once the issue of images arose, however, Muslims needed an authority to cite, and a relevant passage existed in the Hadith, the compilation of oral tradition handed down from the time of Muhammad, which had acquired the status of law in Islamic society. According to Rudi Paret, an expert on the subject, various revisions to these texts had been concluded by the middle of the eighth century.[15] This made it possible to trace the taboo on images back to the closest associates of the Prophet. With this kind of assurance it became a shielded part of Muhammad's legacy.

If one takes a closer look at the texts of the Hadith, it is hard to avoid the impression that the prohibition of images was based not only on the conception of God as invisible but also on a second factor that is usually overlooked. I will call it the *theory of the nature of life.* Such a theory can be derived without difficulty from the Islamic understanding of the creation. God's creation culminates in living beings, but as they are themselves created, they cannot also be creators. In the narrower sense, living beings have "the breath of life," that is, the ability to gaze, move, and make sounds. Trees and other plants lack the "breath of life," by this definition, and the distinction was supposed to be reflected in images. Even though the vegetal world was created by God it did not possess the same appearance of life. The definition of nature as God's creation did not permit human imitations in the form of artifacts. Pictures and statues could only *imitate* nature but could never *be* nature; such representations of living creatures *(hayawân)* offended God because they lacked the breath of life and were thus forgeries of creation.

Painters, who were creatures themselves, acted like creators when they violated the prohibition against pictures, and on the day when the dead were raised from

their graves their offense would become public. When God demanded that artists give life to what they had created, they would have to admit with shame that they could not, since they had created only the appearance of life. By forging the creation they had even compromised it. If artists desired to express themselves, they ought to content themselves with pictures of "trees or of things in which there is no breath of life."[16] Such pictures also seemed inoffensive because they "are ornaments [*nuqûsh*] and resemble the patterns [*'alam*] on fabrics for clothing." Motifs of the kind used in decorative practice, with their repeating patterns on ceramics or cloth, were free of the suspicion of an impure mimetic intent. *Mimesis* thus acquires a negative sense here, not as an imitation of the world but as an imitation of *the Creator.* This was already potentially present in the second commandment of the Hebrew Bible, which referred not just to idols representing other gods but also to making "any likeness of what is in the heavens above, or on the earth below, or in the waters under the earth" (Exodus 20:4). When the mathematician Alhazen speaks of "figures," he means not depictions of living bodies but geometric patterns on an object or a wall (see p. 109).

The prohibition affects a particular class of picture that strives to reproduce pictorially any life form possessing vocal cords and breath. It was prompted in part by the ancient fear of the magic of the evil eye, which could lurk in such images and draw a person's gaze toward it. To avoid this danger, Islamic texts banned all artistic depictions of subjects that presumed to look at a viewer or invited his gaze. Images should not entice an observer to exchange glances, as one could do only with a living person. Even when someone merely glanced at such pictures, the unspoken premise was that he could mistake them for living creatures. The *prohibition of pictures* is just as important as the *prohibition against making idols,* and for the same reasons. Images could not seduce an observer and his gaze if they were on the floor or existed inconspicuously on a carpet. If you were treading them underfoot you couldn't be staring at them or take them to be living creatures. If such images were "on a wall, however, or on a curtain, then they are like an idol" [*sanam*]. A pious Muslim was not supposed even to enter a room in which such images were displayed. One way to protect oneself from pictures of living creatures was to cut off the heads and show them without a face, since "a picture is the same as a head. If the head is cut off, then it is no longer a picture."[17] The equation of a picture with a head is significant in anthropological terms, since it is the head in a portrait that gives the impression of looking back at a viewer, and for this reason one could mistakenly think the representation was

alive. If an image does not gaze at a viewer it does not fall under the taboo but is transformed into a lifeless thing or a neutral ornament.

Rudi Paret found 180 variations on this "tradition" from the time of Muhammad, which he divided into groups by theme. One variation mentions "a curtain with images on it" and cushions of a similar kind. When Muhammad's wife hung the curtain in front of the door to the house, he ordered her to take it down. In another version we read that angels would "not enter a room in a house [*bait*] in which there are pictures," unless they were "merely decoration." Another version runs that they would also not enter a room if it contained a dog or a picture of a living creature. Images were unclean in that they muddied the dividing line between living beings and artifacts; they were neither genuinely alive nor mere objects. In yet another version the prohibition applies only to three-dimensional images "that cast a shadow." These were forgeries in a twofold sense, since they depicted bodies in a forbidden manner and also possessed false bodies. This same version of the Hadith contains the threat mentioned above, that at the Last Judgment image makers would be ordered to breathe life into their images and would prove incapable of doing so.[18]

When Islamic apologetics *(kalâm)* prevailed in the Abbasid dynasty, the commentaries on the tradition delivered an even harsher verdict against images. In a fatwa the scholar Nawawi stated that "the great teachers of our school have determined that painted pictures of every kind of living creature are strictly forbidden and constitute one of the mortal sins. It is equally forbidden to make any object on which a living creature is depicted, be it hung on a wall or worn on a piece of clothing. In this matter there is no difference between what casts a shadow and what does not cast a shadow."[19]

In such Islamic texts pictures and images are treated as forgeries when they attempt to compete with life. Even the Greek term for painting must have given offense, since *zoographia,* and the word for painter, *zoographos,* were composed of the roots *zoon,* "life," and *graphein,* "to draw" or "to write." They meant not only "painting or drawing from life" but could also be understood to mean that paintings captured life or attracted life to them as the other arts could not. Philostratus begins his famous treatise on a collection of ancient Roman paintings with the statement that anyone who scorns painting is unjust to truth and also unable to appreciate literature.[20] The reply to this from Islam would have been that painters could depict only borrowed life or a lifeless replica.

The same subject—mimesis, the mimicry of life in the arts—had already drawn

criticism from Plato. He rejected both painting and literature as dead media, accusing writers in particular of counterfeiting living speech as pictures counterfeited life. In *Phaedrus* Plato mocks people who ascribe truth and life to the written word: "Writing [*graphe*], Phaedrus, has this strange quality, and is very like painting [*zoographia*]; for the creatures [*ekgona*] of painting stand like living beings, but if one asks them a question, they preserve a solemn silence. And so it is with written words; you might think they spoke as if they had intelligence, but if you question them, wishing to know about their sayings, they always say only one and the same thing."[21] Iris Därmann speaks in this context of "zoographic displacement," noting that pictures and writing are at the "interface of presence and absence" and hence ambiguous. According to Plato both painting and writing must fail, since all that either medium can produce is "an illusion of vitality."[22]

The post-Babylonian Bible increased the status of words as the medium employed by God to the same extent that it branded images as a violation of God's will. The Bible derided images as a shameful feature of polytheism, since every tribe created its own idol, whereas the God who was one and invisible could be universal and unmistakable only in the written word. As Régis Debray observes, the medium of writing acquired an irreversible monopoly in the "alphabetic lift-off" of monotheism.[23] Islam was the inheritor of this legacy and used it to legitimate its uncompromising resistance to the tribal cultures in which there must have been a tradition of "living images" of the kind we encounter later in Hinduism.[24] Of course we have no written source for this, and after Islam proved completely victorious there was no reason to attack the idols of the defeated tribes. They had been shattered and destroyed. By contrast Christianity justified its images on theological grounds and thus, among Muslims, fell under suspicion of a relapse into polytheism.

In the West the Roman church was sending missions to new regions such as England and Ireland, where—to put the matter simply—they faced a contradiction between the Old and New Testament on the subject of images. This inconsistency called for a decision or a resolution of some kind. The English theologian Bede, whose epithet is "the Venerable," refers to the subject in his work on Solomon's Temple in Jerusalem, composed in 731. Since there is frequent mention of the adornment and decoration of the Temple in the Old Testament, Bede questioned to what extent the Jews had observed the prohibition of images. He also mentions the "iron snake" that Moses raised, because he was aware that Christian theologians had interpreted this as a prefiguration of the savior on the cross. In addition he describes artists' representations of the crucifixion in terms of their

benefit for the illiterate, as a living lesson or reading *(vivam lectionem)* of salvation history. To strengthen his argument Bede observed that the Greek word for painting, *zoographia,* means "living writing" *(viva scriptura).*[25]

Bede's language would not have found acceptance in Islamic circles, however, quite apart from the fact that Islam did not recognize Jesus's death on the cross. Bede would have been suspected of devaluing the word compared with images. How could painting give life to the writing that transmitted God's living word, for example? In Bede's time writing was a new medium for the Anglo-Saxons that had been brought to his land by Christian missionaries. As a missionary he saw no discrepancy between writing and images when the goal was propagating the word of God, for he was also heir to the legacy of late antiquity. In Islam, however, this legacy was rejected. The Word, as the medium of God's revelation, enjoyed a monopoly that excluded pictures altogether. The Word was recognized as the authentic voice of God, which could be preserved and transmitted only by means of writing. An invisible God "spoke" it, who did not reveal Himself in any physical or visible manner. This is why writing was the suitable medium. Its abstraction made it so dissimilar to the physical world that all idol worship was rendered impossible, as were all attempts to reduce God to human terms and a human appearance.

The Koran as Scripture and Script

The monopoly of the word in Islam's self-understanding is established in the Koran as revealed to the Prophet. The word *Qur'ân* in Arabic derives from the verb for "to read" or "to read aloud," for God's word had to be read aloud to the faithful so that they could memorize it. Someone who had achieved this became known as a *hafiz* or "guardian" of the Koran. The process depended in turn on the medium of writing, in which the Word was fixed and secure. The Prophet himself had not received the Word in written form, in contrast to Moses, to whom God had given the Ten Commandments on stone tablets. The early interpreters of the Koran emphasized the fact that the Prophet was illiterate and possessed no divinely inspired text himself; instead he had to hire scribes to put down the revelation in writing. The Koran was nevertheless regarded as God's Book. It mentions that the Angel Gabriel brought the "messenger" the Word, but what do "brought"

and "Word" mean here? However the word of God was transmitted, once it was recorded, the written form acquired sole and binding authority.

The date when the text of the Koran was fixed in its present form remains controversial, but it was certainly not during Muhammad's lifetime, since in that case the early caliphs would not have had to concern themselves with its recension.[26] Thus there remained a certain tension in the Koran regarding the relationship between *word* and *writing,* between divine revelation and human effort. If God had not sent it as a written text, then it had first been recorded by human hands, although of course from dictation by the Prophet. The written form therefore became the exclusive medium for the word of God without *being the Word itself.* The various writing styles in the transmission of the Koran also prove that the writing style was not taken to be unalterable, let alone itself divine. That applied only to the Word. And yet—or for precisely that reason—it was considered essential to establish a single authoritative form of writing and not to leave it to the tastes of individual scribes. A single form would symbolize the authenticity of the tradition, thereby protecting it, while fine calligraphy could convey the supernatural authority of the Word.

In a sense, writing had come to embody the divine word. It was venerated as the only vehicle for conveying the Word, even though a mysterious distance remained between the two. As we shall see, writing was a means not just of *recording* the word of God but also of *embellishing* it, making it more beautiful. As such it acquired its own devotees; the veneration of the written Koran led to the rejection of all pictures and illustrations made by human hands. The faithful attached greater value to the beauty of the book as text than to pictures, which had no direct connection with divine revelation. It appeared in this light not as communication between human beings but as a communication from God to humankind. Writing (script) made God's word—which the faithful could not receive as a direct communication themselves but could only read or hear read aloud—visible to them, but not in the way that pictures do. This helps to explain why script and calligraphy spread beyond books to the walls of mosques and tombs, increasing the public visibility of passages from the Koran.

Consensus existed on the fact that the "Word" was "uncreated," but not on whether the Koran was uncreated as well. Every copy of the Koran was venerated like a cult object, but in an entirely different way from how Christian icons were venerated, since no copy was more authentic than another. It sufficed that the text was authentic. Thus once again writing and the Word were separated. But what ideas were associated with the "uncreated word"? It was not a creature in the sense

of created nature, but rather the language of God, God's expression of Himself. Equally important was the contrast to the Christian definition of the "Word" that had become visible and made flesh in Jesus. The Latin translation of the Gospel according to John uses the term "word" *(verbum)* to render the Greek *logos.* Muslims would have been able to agree with the gospel's statement that "the Word was with God," but they would have had problems with the second part of the sentence, "and the Word was God." And the problems would have become very evident for Islam when the text later says: "And the Word became flesh and lived among us, and we have seen [*vidimus*] his glory" (John 1:14). Whom did one see?

For Islamic monotheism the "Word" was not a person and did not possess a human body. Belief in its "incarnation" was categorically rejected, as Jesus was only an "emissary" of God, in the Islamic view. Harry A. Wolfson introduced a new term for this distinction, speaking, in the case of Islam, of an "inlibration" of the Word.[27] God's word became embodied not in the flesh but in a book, the Koran. One might even go a step further and say that in Islam the Koran occupies the place that Jesus has in Christianity: It is the revelation of the Word.

The essential difference concerns the issue of images, for when the Word is written down as script it contains no pictures like the ones that have been painted of Jesus. Calligraphy in Islamic art has been repeatedly characterized as an "image of the Word"—a phrase that appeared in the title of a book by Erica Dodd and Shereen Khairallah—but that is a metaphor.[28] It is true that in Islamic culture all the cultic acts were performed with the written word and the book that in other religions were devoted to sacred images. One cannot use the same term for writing, with its language of signs, as for the representation of a physical body and a human life. The aversion to forgeries of creation that is forcefully expressed in Islamic texts offers sufficient warning against simply transferring the definition of an image to language and writing. Writing is not mimetic; it does not depict what it expresses but exists at one remove from it. The Word cannot be made visible any more than God Himself. It is merely speech. Writing records speech without depicting the speaker.

In Islam, veneration of the "uncreated" Word was transferred to the book and to every page that provided writing with a physical body. It was possible for quotations from the Koran to "migrate" to bowls or buildings, but the place God intended for it was *in the book* and *as a book.* As the Koran states again and again, God planned his revelation to be given in the Arabic language and in book form. If script was the "body" of the Word, then the book in which the Word was writ-

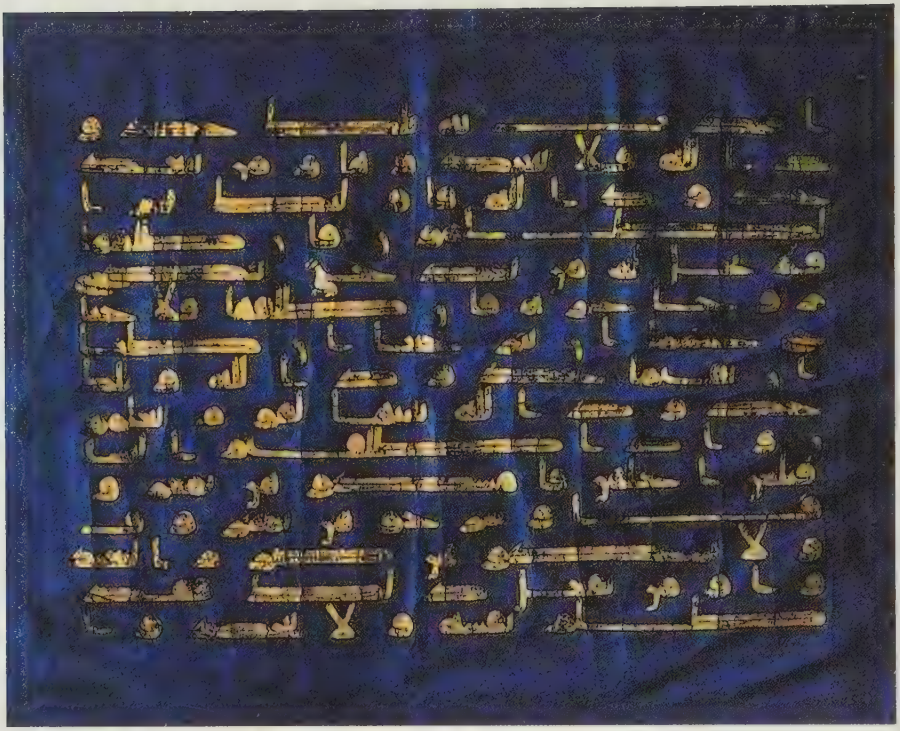


Figure 22: Page from the "Blue Koran," probably Tunisian, from the tenth century (Harvard Art Museums, Arthur M. Sackler Museum, Francis H. Burr Memorial Fund, 1967.23 / Katya Kallsen © President and Fellows of Harvard College).

ten down also constituted part of that body. There, every word was physically located in its proper place, just as it had an assigned place as part of the content of the text. The book was a mirror of the revelation as a single entity and as a whole. In early versions of the Koran, one already measured the text by the number of words, numbers that identified it as a finite and complete organic form, consisting of 114 suras, or chapters; 6,236 *aya*s, or verses; 77,460 words; 321,250 letters; and 156,051 diacritical marks.[29] These figures refer to script as well as to the Word, since letters and diacriticals can be found only in writing and not in spoken language.

The proportions among verses, words, and letters acquire an aesthetic quality that occupies the place taken in other books by images. Proportions also play a large role in Alhazen's theory of optics (see p. 106). They figure prominently in the major reform of writing—known as *khatt al-mansub,* or "well-proportioned calligraphy"—that was introduced at the court of the Abbasid caliphs in Baghdad.[30] This reform occurred in the period when Alhazen was receiving his training (see Chapter 3), and the "geometric style" or *girih* ("knot") style was to be-

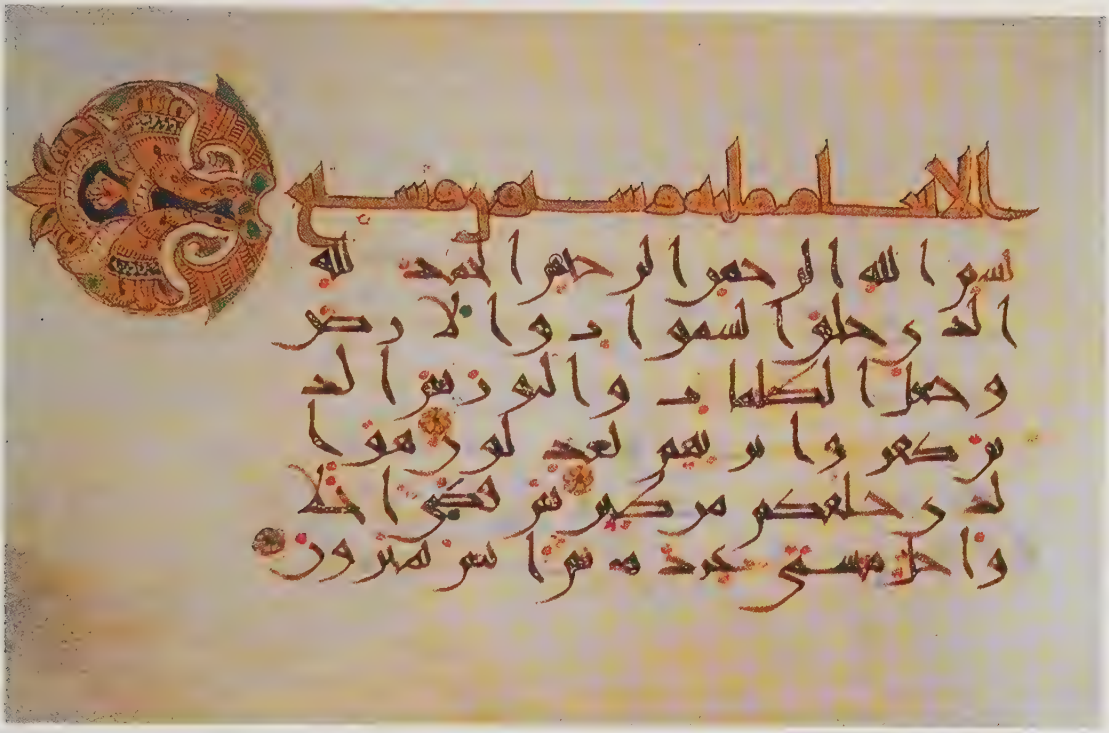


Figure 23: Page from an early Koran, possibly ninth century, Metropolitan Museum of Art, New York (courtesy of Oleg Grabar).

come the dominant feature of Islamic art. Around the year 1000 CE a new wave of orthodoxy led to changes in all areas of religion and culture that would come to define Islam's outward appearance.

It was not just any professional scribe but the vizier Ibn Muqlah himself (died 939) who invented proportional calligraphy. This method took as its basis the rhombus-shaped dot made by placing a calligraphy pen on a writing surface, pushing it open, and closing it again. A scribe could choose to make the letter *alif*—a single vertical stroke—three, five, or more dots long, and the module he selected determined the size and shape of all other letters in prop ortion. The vizier's innovation was the culmination of developments in Arabic script that had begun in the ninth century. Oleg Grabar speaks of the new aesthetic possibilities for configuring individual letters as being similar to the idea of different keys in music (Figs. 22 and 23).[31] The hierarchy in the writing reflects, in the act of reading, a specific practice of perception that Alhazen describes in detail (see p. 113).

A major achievement of this reform is the Koran made by the famous calligrapher Ibn al-Bawwab in Baghdad in the year 1001 CE (now in the Chester Beatty

Figure 24: Page of text from a Koran by Ibn al-Bawwab, 1000–1001 CE (© The Trustees of the Chester Beatty Library, Dublin).

Library in Dublin).[32] It is the form of the pages of this work that determines the dominant impression: each page appears as a self-contained whole (similar to the kind of picture that does not exist in this culture). The book is always conceived in the symmetry of the double page, even if both pages have a different layout: No matter to what page it is opened, the book presents a complete design to the eye, a whole that enables readers to immerse themselves in the text before them. This principle remains valid even on pages where there is no text and the book presents itself as pure ornament; such a double page offers a nonrepresentational basis for meditation yet acquires a semantic character at the same time. On each page of text the closely interlaced script is formed—almost as if in one continuous breath—into a sumptuous block, in which decorative lines are interspersed among lines of text, and palmettes on the sides accompany the script like exclamation points (Fig. 24).

The ornamental pages offer the reader or meditator a pure, geometrical decoration that occupies the space of the body of the text but is framed the way pictures are. Here the palmettes are drawn on a larger scale and their surface filled with minute patterns in the incipient "knot" style, turning them into mysterious symbols with a revelatory character. When the user opens the Dublin codex to one of these double-page decorations, he or she turns from a reader into a viewer (Figs. 25 and 26). These ornamental pages not only serve to introduce and separate the book into sections, they also transform the perception. While they follow the organization of the textual pages, they replace the block of writing with geometric fields that belong to a single page and yet refer to the book as a whole. The rich ornament makes this Koran into an exceedingly precious object. The geometric design takes on the character of a cosmic system of signs in which the viewer's eyes are disciplined but at the same time stimulated. The relationship between figure and ground in a picture recurs here as the relationship between ge-

ometry and page. In this analogy the ornamental page seems abstract to our modern eye, but we have not acquired the practiced gaze of the Muslim reader.

For the trained eye, reading and viewing here became indistinguishable. This is why Alhazen could easily apply his theory of perception to Arabic script (see p. 113). Precisely because reading and seeing occurred without representational images, the combined activities could stimulate a visual meditation of a special kind, one centered on a reality that necessarily remained invisible and yet was physically present. Oleg Grabar ascribes to Arabic calligraphy, as well as to Islamic geometry, the task of a kind of "mediation" that differs fundamentally from every kind of illustration and from iconography in general. Script and ornamentation both occupy the threshold between visibility and invisibility, between presence and absence, without one contaminating the other. The scribes and artists who produced such books did not illustrate but directed the eye to what could not be depicted, even though—paradoxically—they did so with visual means. Clearly they made it their task to purify a merely sensory perception and to guide it toward inner images.[33]

We find geometrical ornamentation comparable to the form on pages in the Koran on surviving book bindings. These too were more than mere decoration, although what that "more" consists of cannot be easily determined. The patterns on the bindings were frequently employed in other genres as well; artists devoted their energies to this repertoire of forms wherever mimetic representation remained taboo. In principle the decorative pages in the Dublin Koran are anticipated in fragments now in the Austrian National Library in Vienna, even though the Viennese fragments are more than a century older.[34] The earlier work does not yet represent a standard or norm, however, nor does it reflect the discipline that later became a characteristic of the Sunni reform. If we go back even further in time, we encounter an early form of book decoration in which scribes were nevertheless seeking a way to ornament pages without representational imagery.

In the early 1970s a spectacular find was made in the Great Mosque of Sanaa in Yemen, when a quantity of ancient Koran fragments came to light. One manuscript from the eighth century with a highly unusual frontispiece caused a particular stir. Instead of abstract ornament it depicts the facade of a building, and the same design is used at the start of several sections in the text (Figs. 27 and 28). The whole page is filled with a drawing of a mosque several stories high, the facade adorned with arcades but without any sign of human occupants. At the bottom there is a closed door at each side, while at the top, trees and other plants are grow-

Figures 25 and 26: Double-page spread of ornamentation (folios 284v and 285r) from a Koran by Ibn al-Bawwab, 1000–1001 CE (© The Trustees of the Chester Beatty Library, Dublin).

ing next to an unoccupied doorway. The arcades are filled with hanging lamps. The center of the facade is occupied by a single plant on a pedestal, framed like a picture. The facade as a whole is also surrounded by a frame but is not intended as an accurate depiction of a real building; rather, it is an emblem that occupies the entrance to the text, reminding readers to enter it as they would a site where the Koran is read and venerated. The plants, which—as we already know—do not

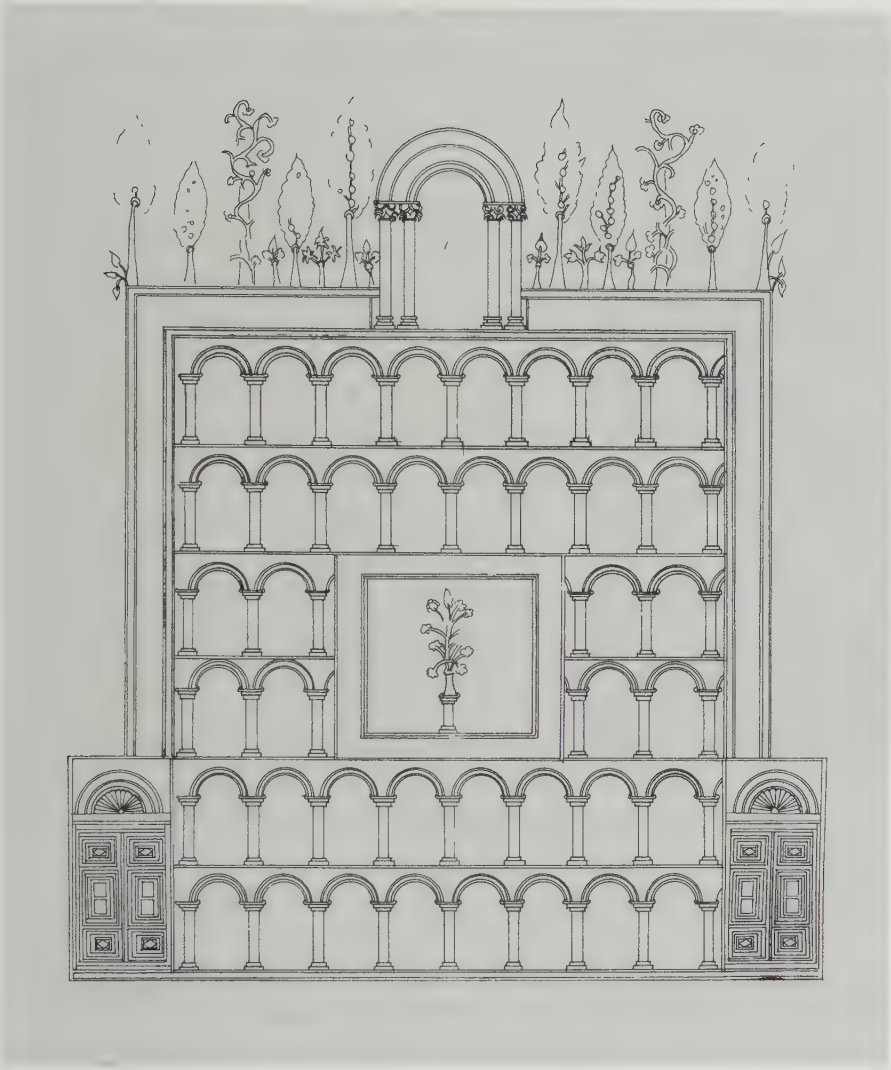


Figure 28: Sketch reconstructing the full frontispiece of the Sanaa Koran (after Oleg Grabar, The Mediation of Ornament, Princeton University Press, 1992; reconstruction by Howayda al-Harithy).

Figure 27: Left half of a two-page frontispiece from a Koran thought to date from the eighth century, Sanaa, Dar al-Makhtutat / House of Manuscripts (© Dr. Hans-Caspar Graf von Bothmer).

count as living creatures, suggest a garden in paradise, similar to the mosaics in the arcades of the Great Mosque of Damascus, which date from about the same period. This fragmentary frontispiece of the Koran is in its own way abstract, though in a different manner than the text.[35]

Arab culture attached great importance to the synergy of script and geometry, which reached a peak in the tenth century. At the same time, this synergy created

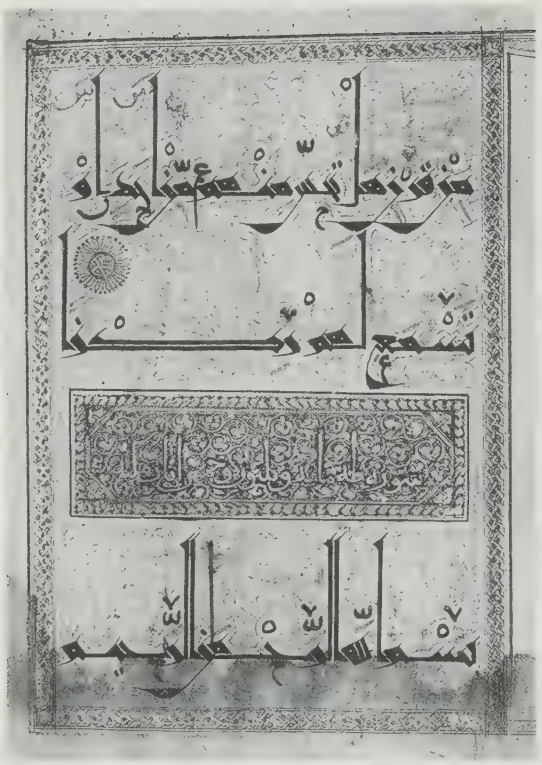


Figure 29: Page from a Koran thought to date from the second half of the eleventh century (courtesy of Oleg Grabar).

a binding aesthetic, providing rules for collective perception. With its formalism and right-to-left orientation, Arabic script established general perceptual norms that were not limited to reading. They also guided contemplation of ornament in books, so that script gradually extended its function beyond the reproduction of texts alone. From the eleventh century on, lavish versions of the Koran were available to art lovers, who acquired them for their collections (Fig. 29). In this milieu collections of art and of books became virtually synonymous. As appreciation for beautiful calligraphy developed, scribes even occasionally sacrificed correct spelling to aesthetic effect. Little by little script thus freed itself from text, becoming an autonomous medium that represented its own reality in addition to the meaning of the words it formed. By providing sensory pleasure—a need fulfilled in other cultures by pictures—Arabic calligraphy turned writing into an art form that was valued and admired for its own sake.[36] In other words, calligraphy pointed to its own beauty.

Under the Gaze of Allah: Pictures as Narrative

Should we conclude that Islamic culture expelled images everywhere and for all time? Did they cede their place permanently to calligraphy and imaginative geometrical design? These questions lead us back, after a long detour, to the question about figurative representations posed at the start of this chapter. Persian miniatures are a highly visible legacy of the Islamic world. When were they painted, and what role did pictures play in that society? When one looks into the subject, it emerges that they were an innovation of courtly culture and came to prominence only in the Mongol period after Genghis Khan's conquest of the Persian

Empire in the early thirteenth century. Most important, such miniatures were always associated with a book whose text they illustrated. In a way they were a continuation of the text in another medium, a narrative of their own. They might simply mirror the text or sometimes supplement it by telling what was not said in the story. Even when portrait painting was introduced at the Ottoman court in the sixteenth century, it started as book illustration, since the book was the only place where pictures were permitted (see p. 54). Books were the home of script and text, but until the nineteenth century they remained indispensable to artists as well, since there was no other medium in which they could work.

Illustrated books may have existed before Mongol rule; some were probably lost when the great library of the Fatimid caliphate in Cairo went up in flames in 1171, as had happened to the library in Alexandria in antiquity. But in all likelihood they represented a special case, being permissible only under certain limited conditions when illustrative material was essential, such as in scientific works. Arabic translations of ancient Greek writings had to reproduce the illustrations in the originals. Drawings of constellations, plants, and animals had a fixed place in this kind of book. In the copies and translations into Arabic they were merely replicas and aids to comprehension, however, and did not constitute a new genre of pictures.[37]

A far-reaching transformation of Islamic art did not occur until after the Mongols had conquered Baghdad in 1258 CE. Having brought with them a pictorial culture influenced by East Asia, and by China in particular, the victors adopted the religion of Islam but in turn imposed some of their own traditions on their new subjects. It is certain that narrative images in illustrated Islamic books did not emerge as the result of an encounter with European art, and thus they have little in common with Western miniatures of the medieval period. The encounter that took place with the art of the Far East was not entirely free of conflict, however. The painted scrolls that Middle Eastern Muslims now came to know represented a new genre to them, since they were used to books in which text was the dominant feature. Frequently, new owners of the scrolls simply cut them apart and pasted individual scenes into albums, which they now began to collect in addition to books.[38] For this reason it is difficult to characterize the imported scrolls from which excerpted paintings have survived. In time, however, the new imported images gave rise to a type of illustrated book that had not existed before. Illustrations began to tell a story of their own, creating a different kind of relationship to the text that changed the layout of pages. It is no great exaggeration to say that illustrated pages now occupied the place in books that had formerly been

devoted to decoration and geometric designs. Artists devised a great many hybrid forms as well, combining human figures and abstract ornamentation.

A certain idea of Chinese culture and its abundance of images is to be found in Persian poetry even before the period of Mongol rule. The great poet Nizami (1141—1209) frequently made use of Chinese themes. In his *Book of Alexander the Great,* the great ruler appears as a visitor at the court in Peking, where he and the Chinese emperor ask Greek and Chinese painters to mount a competition for which the two rulers will act as judges. It is significant that in this fable Nizami is concerned with two cultures that were both foreign to him and also strange because of their figural art. The fable shows them mirroring each other, in a quite literal sense, in their use of art, since the Chinese use a large spherical mirror to duplicate or reproduce the works painted by the Greeks. When the curtain that separated the two groups is pulled back the judges see the same picture on both sides.[39]

Another work by Nizami that tells the story of King Bahram and his seven wives contains a reference to "picture houses" in China. When the hero enters a locked room for the first time he discovers "exquisite pictures" on the walls. The pictures, which have no equivalent in Nizami's own culture, depict seven princesses—one for each planet—whom he will meet once he becomes king. As portraits of individuals, they would constitute for Nizami a most unfamiliar artistic practice, but it transpires that they are not portraits in our sense at all, but visions of the prince's future, that is, mental images. When Bahram sees the "idols" of the seven women before him, they do not return his gaze but turn instead to face an image of his future self as king, which appears in their midst. What is still a purely imaginary scene will become a reality only later in his life.[40]

Nizami's poetry became a popular theme for artists under the Timurids, who ruled Persia in the fifteenth century. As a secular genre in which life at court could be depicted, book illustration was free of religious constraints. The cultural importance such illustrations acquired created a demand for lavish editions, which became collectors' objects for the nobility. One such edition was included in an anthology created around 1410 CE for Iskandar (Alexander), the grandson of Timur (Tamurlane). It includes a set of thirty-eight illustrations, among them a depiction of Prince Bahram's visit to the picture gallery (Fig. 30). This theme had confronted the Persian artist with certain problems. He had to furnish the room with pictures for which he had no model and which could not be shown as hanging on the wall, since that was forbidden.

He found an ingenious solution by replacing the portraits with the women

Figure 30: Prince Bahram Visits the Picture Gallery, illustration for Nizami, The Haft Paykar (Shiraz, Persia, 1410–1411), Gulbenkian Museum, Lisbon (Calouste Gulbenkian Foundation).

themselves, who are shown, framed like pictures, each sitting in her own domed room of the palace, one that at this point in the story has not even been built yet. The women invite the hero to look into the future rather than at their portraits. In this way, painted pictures are replaced by a glance into the later life of the hero, whose mental images are projected outward. The women are sitting in a semicircle in an ornate palace room that gives the effect of a folding screen, before which the prince is standing. Three-dimensional space and two-dimensional surface merge so as to become indistinguishable, as do the pictures of the imaginary palace and the palace itself. This enabled the artist to solve the challenging problem of spatial depiction, since the room consists only of a semicircular wall surface shown at a slight angle and a tiled floor folded into the surface and presented in elevation. Ornamented bands join the different facets into a whole; no attempt has been made to relate the palace room spatially to an observer. It is only the visitors, including Bahram as future king, who bring motion and narrative into the otherwise wholly static painting.

I should remind the reader that this picture was painted at almost the same time that linear perspective was invented in the West. It is not simply "backward," however, but rather offers an alternative to the perspective gaze. It uses a narrative style that becomes self-contradictory if Western descriptive terms are applied to it. Comparisons with medieval Western illuminated books may be possible, but this work is based on a different conception of art and is rooted in different traditions that set it in clear contrast to Western standards. Its aesthetics can be deciphered only by an analogy with "reading." A reader is used to acquiring an overview of the narrative and regarding it from the narrator's viewpoint. One picture may contain several stages of the narrative, making use of a "narrative space" that is not the same as space in a landscape or an architectural setting.[41] This method is not limited to Islamic art, however. It follows the principle of "continuing pictorial narrative," which does not obey the modern unities of space and time on which linear perspective is based. Yet the technique used by Islamic painters had a specific quality that requires further consideration.

In Islamic books, images and text entered into an alliance that serves to tame the gaze. Viewers could not investigate the world on their own but remained tied to the text and guided by it. If they looked at the pictures in the book with a reader's eye, they always knew in advance what they would see and had learned in what way and in what order it was to be seen. Pictures of this kind reproduced not personal experience but collective knowledge. Readers recognized in the images what they knew from the text and even judged the painters by how well they had

understood it. For their part the artists used an established style to illustrate a particular work, so that it was even possible to recognize the models they had followed. The possibilities for originality were just as limited as those for writers retelling an old story. In the text, every picture not only contained instructions for how to look at it but also had limits on its freedom, a boundary where its authority ended. The viewer who "read" a picture already knew the story, so it added nothing new or extrinsic to the text. For both artist and viewer, a text served as a limit and guide.

This had a practical significance as well. The bird's-eye perspective, which offered a panoramic view of the world, was neither the viewer's nor the painter's; instead it enabled everyone to "read" the world in the same way from a standpoint that transcended the personal. All the details in a picture remained equally small and distant for the viewer, so that the course of events within the narrative emerged clearly. Just as a text was written by someone other than the reader, so too a narrative in pictures had been painted by someone who could not be the viewer and who had used specific rules—for narration, and also for reading and viewing. To assist people looking at a book so that they did not lose the thread of the story, many miniatures included pieces of text within the picture field, and sometimes a picture would extend into the area of text. In this way the boundary between image and text always remained open. The acts of reading and looking at a picture could reinforce each other or even flow together. Ultimately narrative meant the presence of a narrator, who explained the world. His authority was greater than what an individual writer could acquire since it was backed by the institution of the narrator. Hence it is understandable that poets possessed a form of authority borrowed from the sphere of religion. The authority of the Word had devolved upon them through the traditions of this culture.

In his novel *My Name Is Red,* Orhan Pamuk deals with the picture concept that the Islamic tradition developed in illustrating narratives. The sultan wants his portrait painted but adds, "Such a portrait will, of course, have to be concealed within the pages of a book." The reason is that people would begin to worship a picture they had hung on a wall, "regardless of the original intentions." One character quotes the sultan as saying: "An illustration that does not complement a story, in the end, will become but a false idol." Since people cannot believe in a story that is absent, they "will naturally begin believing in the picture itself." The uncle of the character called Black says to him: "Every picture serves to tell a story." On a visit to Venice he had stood in front of a painting and wondered what narrative it was meant to embellish and complete. Slowly he sensed "that the un-

derlying tale was the picture itself. The painting wasn't the extension of a story at all. It was something in its own right." That was foreign to him, and he naturally preferred pictures that accompanied stories. Pamuk has an Ottoman manuscript illuminator say that the living power of an Islamic picture stems from the way it "depicts the world from an elevated Godlike position attained by drawing . . . a horizon line" at the top of a painting. Then it shows the view that Allah has when he looks at his world.[42]

Blickwechsel: Pictures with a Living Gaze

There is probably no greater contrast to the pictures we have just been discussing than the modern Western kind that look at us or—let's say it right away—look *back* at us when we direct our gaze toward them. For this to happen, they first of all have to be pictures with figures that can look or appear to be looking—that is to say, figures who are represented as if we were encountering them in real life. They gaze out of paintings that we stand facing at eye level. The artists set out to make us forget that we are standing in front of pictures and not real people. The modern picture, which is rooted in the invention of perspective, can scarcely be understood without the exchange of glances with which it claims the viewer's attention. This face-to-face encounter is the hallmark of a society that has chosen to depict its own practice and standards with regard to looking; its pictures reflect the way people look at each other. At this point paintings cease to be mere objects and begin to occupy the place of living subjects. In the Renaissance, long before the invention of modern media, they already asserted their own claim to be "live" pictures. In other words, the pictures indulge in a permitted fiction, the kind of imitation of life that was considered positively sinful in Islam. As we have seen (p. 62), the key obstacle in Islam to accepting images of living beings was that their makers had usurped the right of the Creator.

The gaze is also a major theme in the work of Jacques Lacan, and he touches on it in one context related to the topic that concerns us here, namely, looking at paintings and exchanging glances with them. As far as I know, the cultural relationship between social viewing practices and practices for making pictures has not had an interpreter who examines the phenomenon as a whole. Lacan identifies the underlying connection with the history of perspective when he describes

how the gaze occurs in a "punctiform" manner and becomes the vanishing point "with which the subject confuses his own failure," meaning that we want to see something but cannot. Lacan defends the visibility of the gaze and its representation when he observes, "Painters, above all, have grasped this gaze as such in the mask," as Goya in particular was able to do.[43]

This is the essential point in an exchange of glances: the *gaze in the mask* is, as I understand it, *a gaze in the mask of life,* which people in paintings or photographs turn on us. They seem to be looking at us with a real face, although they have to use a mask to do so. The fiction begins with the viewer, but all the people represented in all kinds of pictures participate in it. They give us a conspiratorial or seductive look, as if they were taking note of our presence. This simulated exchange of glances reflects the theater of the gaze, which Western society kept going by constantly imposing new conventions. Hence we can speak of an *iconology of the gaze* in the sense that pictures depict genuine gazes and gazes are made into pictures where the social and cultural practice of looking is reflected as if in a mirror. If picture and gaze have entered into an alliance with each other, then this alliance was founded essentially on the perspective model.[44]

An equally crucial role was played by the portrait, which entered art history at the same time as the perspective picture. In speaking of portraits, Jean-Luc Nancy observes that in the painted gaze "the picture itself becomes a gaze. The whole picture looks," although in fact only the face within a portrait can do so. Furthermore, Nancy continues, this kind of look creates an "intimacy that can exist only in the here and now."[45] In real life, glances must be exchanged at the same time, so viewers must project their own time onto a portrait if they are to perceive the presence of the person in it, and they have to do this if they are to believe in his or her glance. This is the quintessence of the "animation" of the portrait, as we may call the viewer's share in the exchange, and many philosophers have seen a problem here. Following Wittgenstein, Nancy refers to the gaze as "what comes out" *(qui sort)* of the portrait and meets viewers, performing an action and claiming their attention. It is in the act of coming out of oneself that "a subject becomes a subject." This also holds true when the subject of a portrait meets the gaze of the living subject, the viewer. The so-called *gaze out of the picture* was a dialogical gaze, which did not become a major topic until the Renaissance; it was, so to speak, a mobilization of painting in the name of life, to which it was attracted. And it was precisely this postulate of life that was rejected in Islam.

In his book *Der Blick aus dem Bilde* (The Gaze Out of the Picture) Alfred Neumeyer took the gaze as his subject and as the subject of art history, but he did

not take the rupture caused by the invention of linear perspective seriously. He saw the gaze from the picture as a reversal of the perspectival contact that a viewer made with a picture, rather than as a mirrorlike correspondence of two actions: the glance at the picture and the glance from the picture. The perspective space of which Neumeyer writes confirms our *presence in the picture* just as much as it does our *presence in front of the picture.* The *dialogical situation* in which the glances of picture and viewer intersect is not the same as a *deictic situation,* in which the picture *shows* something to the viewer.[46] The gaze outward takes on a special quality when it is the artist himself who looks out from his work and at this moment interrupts the narrative of the picture. By doing so he claims the painted scene as his own invention for which he holds the copyright, and he makes the viewer his accomplice.

Alois Riegl described Dutch group portraits of the seventeenth century in terms of "the gaze out of the picture," as if the phrase had been invented for them. The connection with the revolution of perspective that had taken place earlier in Italy plays no role in his discussion.[47] The guilds and associations of Dutch burghers were reflected in paintings in which they looked out intently at their fellow citizens, as if they were about to call them as witnesses or wanted to recruit them as members. It may have been just as important, however, that they appeared in the picture at all and were immortalized there; it was a way of reconciling personal identity with social integration. Within the associations and clubs, members made contact with one another with their voices and glances, too. If a speaker stood apart from his group, their presence in the portrait connected him with them. Viewers, for their part, felt included in the social network that was depicted in the painting. The fictitious exchange of glances became even more meaningful when a picture of this type hung in the place where the group met. The members celebrated or argued with one another in the pictures just as they did in real life, demonstrating in a manner particularly representative of seventeenth-century Holland that an exchange of glances could also be practiced with a group portrait, crossing the threshold between art and life.

The fiction that pictures return our gaze also includes an alternative—that they refuse to do so, when the respective figures are portrayed as if they felt unobserved. Then they turn us into voyeurs. The glance that is not returned is just a variation of the glance that is. In the first case we are directly "addressed," and in the second we remain concealed observers of others' intimacy. Art critics of the eighteenth century discussed this very topic, as Diderot bears witness.[48] Both types of mise-en-scène demonstrate the degree to which Western visual culture

was fascinated by the gaze, whether overt or covert. The conventions that applied in front of the picture were supposed to apply within the picture as well. An exchange of glances with pictures replicates the exchange of glances in real life. The way we experience the return of our gaze is altered in photography and film, however: In photographs we always know that the subject is actually looking at a camera, and in films an actor felt to be looking directly at *us* would destroy the fiction on which the film depends.

In paintings from the Middle Ages we search in vain for a gaze out of the picture, because the viewer is tolerated only at a distance, in the collective form as a congregation or as a reverent eyewitness. In the late medieval period this hierarchy of painting and viewer was abandoned, step by step. Religious paintings paved the way for the visual shift toward early modern culture, fully achieved in the perspective picture in which the gaze has seized power. This also holds true for portraiture, which was not simply about making a likeness of someone. Portraits stirred fears about the ambivalence between reality and appearance, fears that arose when art approached the vicinity of death, since a painted gaze always reaches us from a different time. It is the exchange of glances between two different time periods that prompts the beholder to perform the task of memory. As a rule, viewers of portraits are exchanging glances with persons who are dead but nonetheless acting as if they were alive. In the case of photography we feel the gap in time even more acutely because the brief moment of the exposure already belongs irretrievably to the past. All these questions arose only when pictures became postulated on the idea that they could simulate life.

The live images in the modern media are just the final consequence of these questions. They satisfy a long-standing desideratum of Western culture by ever more convincingly simulating an exchange of glances with living persons. Live electronic transmissions have such a minimal time delay between filming and broadcasting that we do not register it anymore, yet their effect, too, is based on a fiction, since the person who appears to be looking at us on the screen first had to look into a camera and be filmed. In addition, many television images that we see were recorded earlier. Since they can be rebroadcast at will, no genuine symmetry exists with our gaze at a given moment. They still rely on our goodwill and suspension of disbelief for their legitimacy. We lend life to them, which we alone possess, in order to make them appear analogous, thereby remaining within the framework of a society that persists in reproducing its viewing practice in pictures.

In closing I want to present one example from Florence that offers a surprising

insight into the close connection between the depiction of a gaze in painting and the perspective revolution that informs my understanding of perspective as a symbolic form (see p. 15). It is a work that attracted attention and critical commentary at the time it was first seen. When Domenico Ghirlandaio was commissioned by the Tornabuoni family in 1485 to paint the main choir in the church of Santa Maria Novella, he filled it with biblical scenes but used the lower zone of the high walls, close to observers, to depict a virtual who's who of contemporary Florentine society.[49] The part of the scene that concerns us here is located at the far right and depicts the annunciation to Zechariah, father of John the Baptist, in the Temple in Jerusalem (Fig. 31). The chronicler of the arts in the period, Giorgio Vasari, praised the lifelike appearance of the figures, noting that Ghirlandaio included "the portraits of a large number of Florentine citizens who were at that time governing the state, and especially all those from the Tornabuoni family (both young and old)."[50]

Figure 31: Domenico Ghirlandaio, detail from Apparition of the Angel to Zechariah, Tornabuoni Chapel, Santa Maria Novella, Florence (Scala / Art Resource, New York).

These portraits would all be merely background figures, extras for various crowd scenes, were it not for the fact that their glances bring them to life. They are standing in a row, but just as the physiognomy of each face is distinctive, so is the gaze. The choreography, which assigns to them places at the front of a stage and on a proscenium, strictly follows the perspective model of visual rays. The same model also applies to the figures' painted gazes and connects them with our gaze. The construction of the painting is so clear that one could trace the geometry of the figures' lines of sight and the orthogonal lines receding toward the vanishing point. They map not only the bodies but also the gazes, which appear to share the same space with the viewer. It is only consistent that some members of the family direct their gaze toward the spot where we ourselves are standing, just as if they wanted to make contact with us. This prevents them from taking any notice of the biblical scene occurring in front of them, a circumstance sharply criticized by contemporaries such as Savonarola, who regarded the simulation of living glances as an error in religious painting. In his criticism he went straight to the heart of the matter, however: This new technique in painting sought to make eye contact with observers, an outcome based on a fiction of life in the picture.

3

Alhazen's Measurement of Light and the Arab Invention of the Camera Obscura

Alhazen's Book of Optics, the *Perspectiva*

Linear perspective for pictures was based on a theory of optics that represented not a new invention but old knowledge. Most of the time it is forgotten that this theory was once known by the Latin name *perspectiva,* which was also the translated title of an Arabic work on optics. The meaning of the theory of vision was altered when it was transferred to a theory about making pictures, but that is what the artists of the Renaissance who took up the new technique called it: perspective. Today we would say that they wanted to create "analog images," and saw in perspective a virtual facsimile of our natural manner of seeing. The Arab *theory of optics* was known at European universities by the thirteenth century, but it did not become a *theory of pictures* until the fifteenth century. The grounds for its transformation were not scientific but cultural.

As we shall see, a conception of pictures was as foreign to Arab science as it was to Arab art, where geometry was dominant. For this reason it makes sense to take a closer look at the terms both cultures use for visual perception. The issue is not so much the relationship between science and art as it is the encounter between two cultures that expressed themselves in both fields. If we wish to examine cultures of both the Middle East and the West without a colonialist bias, then there can be no privileged standpoint from which an older culture is admitted to have exercised an "influence" on a modern one. Cultural studies today should give up using the West ("modernity") as a universal standard. In this particular case the issue of pictures separates the two cultures precisely because it reflects their different practices with regard to visuality and the gaze. The difference involves not just art but also a mind-set and relationship to the world.

In what follows the focus will be on a mathematician who has been referred to

Figure 32: Iraqi banknote (10,000 dinars, 2003) with a portrait of Alhazen (public domain).

as "the Arab Archimedes": the mathematician Abu Ali al-Hasan Ibn al-Haytham (965–1040 CE), who became known in the West as Alhazen, a Latinized form of his given name.[1] A deviser and conductor of experiments who invented the camera obscura, Alhazen anticipated the modern scientist and placed the work of Euclid and Ptolemy on a new footing. It becomes evident in his aesthetics that he was both an exponent and interpreter of the culture of his time. In the theory of optics, which will occupy us above all, he had an influence on Western science up to the era of Kepler and Galileo, who built on Alhazen's work and at the same time took the first steps beyond it. Outside the history of science it has been forgotten that his main work, the *Book of Optics,* bore the title *Perspectiva* in translation until Friedrich Risner, who brought out the first printed edition, substituted the Greek term "optics." The latter has since become a standard term in the field of [visual] perception.

Alhazen was born in Basra, in present-day Iraq, and educated in Baghdad before he entered the service of the Fatimid caliphs, who had just founded Cairo. A failed attempt to regulate the flow of the Nile brought him into conflict with the caliph al-Hakim. After that he withdrew from public life to his house near the Azhar Mosque, supporting himself by making translations and copies of scientific works. Today a portrait of Alhazen appears on an Iraqi banknote (Fig. 32), but his actual appearance is not recorded. Of the ninety-two books he is known to have written, fifty-five have survived, including an autobiography from the year 1027.[2] Shortly before that he wrote a "summary" of Euclid's geometry and Ptolemy's di-

optrics, the first book of which he reconstructed. Then Alhazen left the Greeks behind, as he himself said, with results that he obtained from his own experiments.[3] In a separate work he offered original "solutions for Euclid's problems"; in another treatise he refuted Ptolemy's planetary hypotheses with his own series of experiments.[4] Alhazen's work exposes as thoroughly false the still widespread view that the Arabs did nothing more than transmit the science of classical antiquity.

In his *Kitāb al-Manāzir,* or *Book of Optics,* which Alhazen began writing in 1028, he was attempting to synthesize physics and mathematics, since his goal was to close the gap between mathematics and empirical observation. In this way he established a new basis for the ancient Greek theory of vision and resolved its inherent contradictions.[5] Alhazen recognized the physical existence of light, which became the dominant factor in his view of visual perception, for he proved in his experiments that rays of light could be calculated mathematically. In Book I of his *Optics* Alhazen discusses the general characteristics of perception; the Book II deals with particular conditions, and the Book III with common errors. In Books IV, V, and VI he investigates further questions, especially reflection of light, catoptrics, and errors of vision. In Book VII he writes about "refraction through transparent bodies whose transparency differs from that of air" (I.1.7).[6]

The work was probably translated for the first time into Latin about 1200 CE in Spain, under the two titles *De aspectibus* and *Perspectiva.* The Arabic version was in everyone's hands among the Muslim elite in Andalusia, as we know from contemporary sources. It led to controversy not only about whether Aristotle's work could be challenged but also about whether philosophy remained an autonomous discipline, and valid, even when experiments cast doubt on its conclusions.[7] The translations had errors and gaps that are reflected in the commentaries by Roger Bacon, John Peckham, and Witelo (see Chapter 4), and these shortcomings still influenced the interpretation of the text when Kepler examined it critically in 1604. Kepler used the edition Friedrich Risner had published in Basel in 1572 (Fig. 33).[8] Only then did Alhazen's theory become scientifically fruitful, because up to that time it had just been adapted or reiterated. This was true particularly for the distinction made between retinal image and visual image after the discovery of the retina and lens, parts of the eye that Alhazen had not known.

Alhazen was definitively identified as the author of the *Optics* when Eilhard Wiedemann discovered in a manuscript in Leiden the Arabic commentary by Kamal al-Din al-Farisi, who names Alhazen and cites him at length. In what follows I will cite from the first English translation made directly from the original Arabic text, published in 1989. It contains the first three of the seven books into

OPTICAE
THESAVRVS.

ALHAZENI
ARABIS
libri ſeptem, nunc primùm
editi.

EIVSDEM liber DE CREPVSCVLIS
& Nubium aſcenſionibus.

ITEM

VITELLONIS
THVRINGOPOLONI
LIBRI X.

Omnes inſtaurati, figuris illuſtrati & aucti, adiectis etiam in
Alhazenum commentarijs,

A'
FEDERICO RISNERO.

Cum priuilegio Cæſareo & Regis Galliæ ad ſexennium.

BASILEAE,
PER EPISCOPIOS. M D LXXII.

Figure 33:
Title page of Alhazen's Opticae thesaurus, Basel, 1572 (Bayerische Staatsbibliothek, Munich).

which the *Optics* is divided and was translated by Abdelhamid I. Sabra, who in his youth met Karl Popper in Alexandria and through Popper came to work at the Warburg Institute in London.[9] Up to that point, the sixteenth-century edition in Latin, which is lacking the description of the camera obscura, was the standard text in the West, although Mustafa Nazīf's critical edition (Cairo, 1942) became available for readers of Arabic. The work of Matthias Schramm and Fuat Sezgin was based on that older edition, as was the research of Saleh Beshara Omar and Roshdi Rashed. While historians of science have clearly recognized Alhazen's extraordinary significance, it tends to be overlooked by cultural historians, apart from a few exceptions, such as José Miguel Puerta Vilchez and Gülru Necipoğlu, but even they have preferred to discuss his work in terms of aesthetics. In research on Western perspective in art, which owes to Alhazen far more than just the term, his name is missing altogether. Robert Klein's work did not prove influential, and David Summers names Alhazen only in connection with the history of the senses.[10]

The cultural exchange between East and West culminates in the history of Alhazen's reception. As a scientist Alhazen laid the foundations for the model of linear perspective in the Renaissance, but the manner in which his work was adopted (and reinterpreted) raises questions that need to be asked. Much time elapsed before Renaissance scientists took it up, and the different understanding of visual issues in Arab and European culture make comparison difficult. In Islam every artifact that we would call a "picture" has remained a foreign element, and the use of the camera obscura reflects this opposition. Not until the West began to use the camera obscura did people begin to say that light "painted pictures" on their walls. Alhazen makes no mention of such things; the "images" of the sun and moon seen during partial eclipses were not "pictures" in our sense of the term. The issue of pictures brings cultural norms into play in the history of science, norms that also apply to the natural sciences and mathematics. This will emerge from the discussion of the terminology that Alhazen used (see p. 105).

Since cultural history and the history of science belong to separate disciplines, connections between them seldom become evident.[11] Furthermore, the question of how Arab research could so easily succeed in refuting the ancient authorities' views on the behavior of light reveals an unexpected connection with the aniconic culture of Islam. Two important developments fall within Alhazen's lifetime: the use of nonfigurative decoration to cover entire surfaces of buildings, and the invention of proportional Arabic script (see p. 113). The mathematician popularized his knowledge in a collection of geometrical and arithmetical problems for artisans, a handbook titled "On Geometrical Analysis and Synthesis by

Way of Examples."[12] Aesthetics and mathematics were expressions of one and the same culture, and each shed light on the importance of the other.

Soon disappointed by the curriculum at the advanced schools in his homeland, where teaching was focused on the Koran, Alhazen began to study Aristotle and ancient Greek science on his own. At the ultra-orthodox court of the caliphs in Baghdad, the "uncreated Koran" was propagated as God's supernatural work. One of the chief controversies revolved around the relationship of a distant God to His creation, which was physically close at hand. Alhazen took sides by devoting himself to research on the natural world as God had created it. He pursued his studies through scientific experiments in which he was free to develop a rational view of the world.[13] The court of the Fatimid caliphs in Egypt appeared favorable for his studies, not only as a source of financial support but also because it offered a more tolerant climate with regard to religion, as can be inferred from the stern edicts against the Fatimids published by the caliphs in Baghdad.[14] Alhazen's biography thus reflects the conflicts between orthodox beliefs and freedom of thought that were convulsing the Arab world at the time. He built up his conclusions himself using logic and the laws of nature, which he derived from empirical observations.

Mirrors provided him with an opportunity to study the geometry of light rays and their pathways, both as reflected light (catoptrics) and refracted light (dioptrics). He knew that light rays are reflected in a straight line from every point on a polished surface, and he used a concave mirror to investigate their curvature with respect to the position of an observer. What became known as "Alhazen's problem" consisted of the attempt to determine mathematically the point at which a ray of light must be reflected on a spherical mirror in order to pass from a given source to an observer. How does it happen that one can see this point and the light source that it reflects at the same time, and always at a particular angle? Christiaan Huygens found a new solution for Alhazen's problem in 1695.[15]

Since his Arabic text became known, Alhazen has been acknowledged as the inventor of the camera obscura, a model of which has been reconstructed at the University of Frankfurt. He used the term "dark chamber" for a box 1.30 meters tall with a pinhole in one wall (*al-bait al-muzlim,* I.3.32).[16] Like his other devices, it was used for experiments with primary and secondary light (Fig. 34). It enabled him to demonstrate that in "a dark chamber the air of which is cloudy with dust or smoke, the light will appear to extend rectilinearly from the hole through which the light enters to the place on the chamber's floor or walls which the light reaches" (I.3.3). If the air and light did not mix with each other in the chamber, then they would also remain on their own paths in the eye. If several lamps are

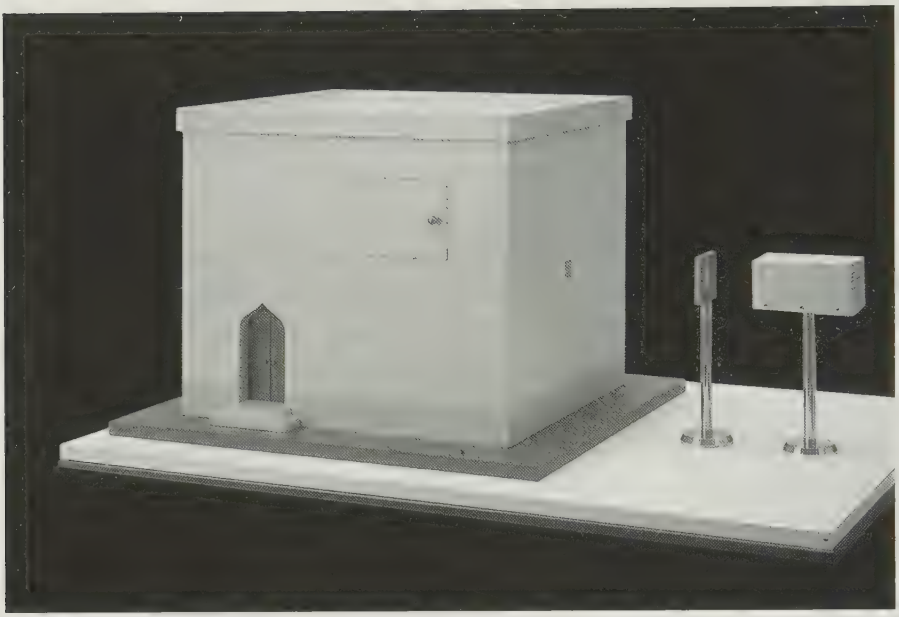


Figure 34: Reconstruction of Alhazen's camera obscura, or "dark chamber." (Institut für Geschichte der Arabisch-Islamischen Wissenschaften).

placed in the same area opposite a single aperture leading to the dark chamber, then "the lights of those lamps will appear separately" on the chamber wall "and in the same number" (I.6.85). All of the rays had to pass through the small opening, but they did not mix with the surrounding air and remained on their paths as they passed through it. Colors also traveled with the light on straight paths (I.6.88).[17]

In Alhazen's work on shadows he described other experiments with the dark chamber that were continued by his commentator Kamal al-Din (died 1320). They dealt with the problem of why, during an eclipse, the sun appears sickle-shaped in a pinhole camera but the moon does not. Researchers describe "images" of the sun, but strictly speaking what they observe are spots of light whose size is dependent on the cone of light formed by the entering rays and the aperture. Kamal al-Din was the first to observe images of a cloud or a bird in a dark chamber, while Alhazen speaks only of "forms" of light. The light from a heavenly body, falling through the aperture, caused cones of rays (pools of light) to form. Because the different pools of light overlapped in the chamber, it was possible to calculate their radius of curvature.[18]

Alhazen knew that the eye functions similarly to a camera obscura, but he was not yet familiar with the retinal image, which, just like the image in the dark

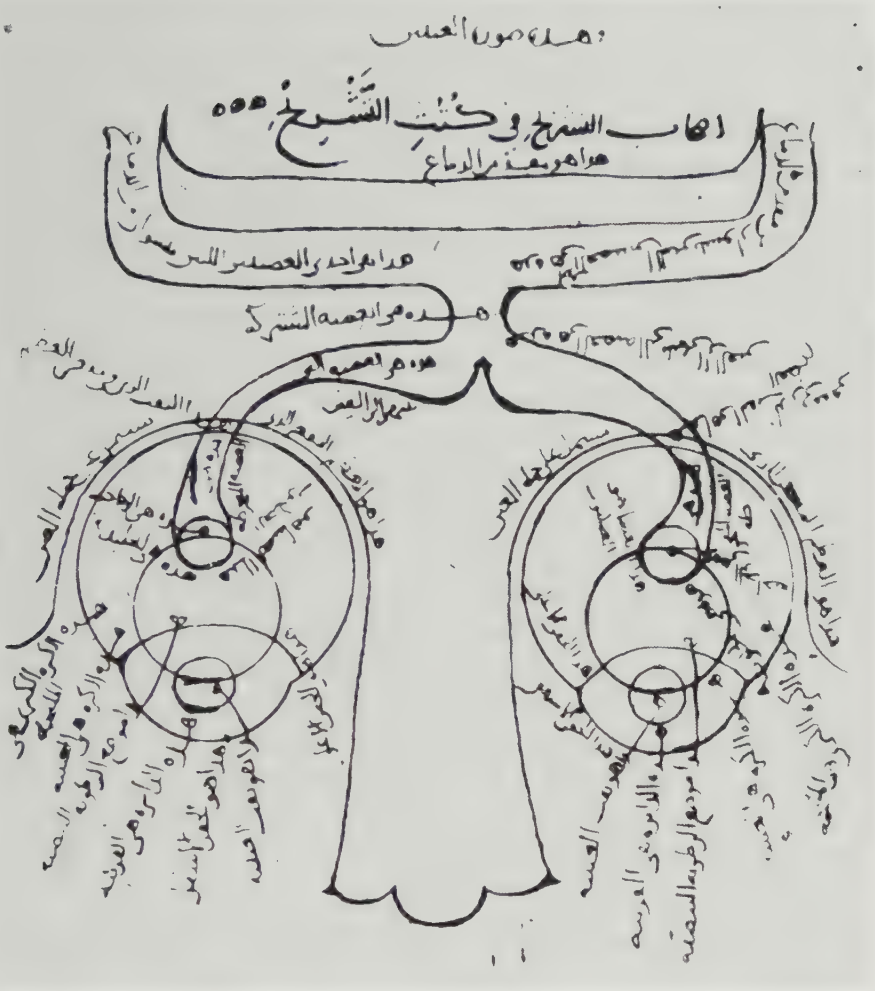


Figure 35: Alhazen's diagram of the eyes, from the oldest surviving manuscript of his Book of Optics, made by his son-in-law and now in the Fatih National Library, Istanbul (Ms 3212, folio 81b). The cornea and uvea are located in front of the round vitreous humor and opposite the crystalline humor (also round) in the center of the eye, from which the optic nerves lead to the brain.

chamber, is upside down. That is why he was unable to transfer all that he observed in the chamber to the eye. He attached greater importance to proving a point-to-point correspondence between surfaces on an object and the surfaces in the eye.[19] So far as the anatomy of the eye was concerned he was still dependent on ancient models that limited his ability to draw correct conclusions. In his view, the "crystalline humor" (I.3.9–10) had the function now ascribed to the lens, of which he had no knowledge. He locates it in front of the "vitreous humor" in the center of the eye, which light reaches through the cornea and uvea (Fig. 35). In Alhazen's time nothing was yet known about the blind spot at the center of the

eye, and of course no one knew anything at all about high-resolution vision (cone vision) and perception of motion (rod vision). Today we know that different sensors on the retina measure light and send this information to the neocortex. Alhazen laid the foundations for further research, however, by investigating the paths that light traverses before the brain processes the data received from the eyes.

By doing away with the "bodies" that had haunted theories of optics up to that time, Alhazen eliminated all anthropomorphic notions from descriptions of visual processes. The ancient Aristotelians had understood the "images" (*eide* and *eidola*) in the eye as copies of objects, but Alhazen resolved them into points of light joined to form an abstract mosaic that he set out to calculate mathematically in Book I.[20] He was aided in this shift of direction by the fact that he lived in a culture with no figurative pictures. When he speaks of "forms of light," he does not mean pictures or images as we understand them today. Furthermore they are always properties of individual objects, and their milieu is not a space with its own epistemic value, nor a space occupied by a viewer. Alhazen speaks not of space but of distances and the effect on light of passing through air and water. Because distances can appear deceptive and changeable, ultimately prior experience is the only way to estimate them.[21] Such knowledge is also required in order to recognize an object in its true gestalt and not be deceived by its appearance, which is variable. Visual images in human beings originate in the brain, which is at a remove from the external senses, Alhazen observes, and medicine has since proved that visual perceptions are carried to the brain by the optic nerve and are therefore cut off when the nerve is injured (I.6.76).

In his physiology of the eye (Book I) Alhazen relied on ancient anatomists, just as he depended on Aristotle's three books about the soul for his psychology of visual perception (Book II). Unlike ancient scholars, however, Alhazen based his analysis of visual perception on a theory of light. He wanted to calculate the paths on which light rays enter the eye using the laws of mathematics. The dominance of light in this analysis has a cultural background. In its omnipresence light represents a cosmic power and is emitted by heavenly bodies, whose "self-luminescence" Alhazen attempted to prove in his experiments. The fact that we are blinded by strong light led him to conclude that light played the active part in vision, and to reject the ancient doctrine that, in the process, bodies were emitted by the eyes. "If . . . the thing that issues forth from the eye is not a body, then it will not sense the visible object, for sensation belongs only to animate bodies. Therefore, nothing issues from the eye that senses the visible object" (I.6.56). Instead we perceive the external world "through the straight lines whose extremities meet at the cen-

ter of the eye," a conclusion that is "accepted by all mathematicians" (I.6.43). Point by point, forms are transmitted from the surfaces of objects along lines that mathematicians call "lines of the ray" (I.6.59).

The measurements of light that Alhazen undertook in experiments with mirrors and various dark chambers represented not only an advance for science but also a new research method, since he was seeking empirical proof for laws that had been calculated mathematically. His approach reflects a different philosophy, quite literally a different way of looking at the world, where physical phenomena seemed to be dominated by light. While light had an entirely different quality than ordinary objects, it was not supernatural or metaphysical but subject to physical laws. At the same time the study of light revealed the mathematical laws that govern the cosmos, in all their abstract beauty. They were not abstract in the sense that they differed from the world, because then it would have been impossible to demonstrate them empirically. Thus what governed the world was neither the gravitational force of matter nor chance but light, and by studying light one could uncover the mathematical structure of creation. As we shall see, light could be represented only geometrically, and not in pictures that were reproductions of bodies.

Distance from Ancient Visual Culture

Much was known in ancient optics about the topics that Alhazen discussed. Nevertheless the majority view remained that motion occurred in two directions in the process of seeing, from the eye to objects and vice versa, and furthermore, that physical bodies left complete images of themselves in the eye. The terminology reflects a passionate and sometimes even phobic relationship to seeing. To begin with, Arabic scholars took their orientation from Euclid and Ptolemy. Ancient optics combined the spreading of light with perception of the world, whereby Ptolemy added the element of visual rays to Euclid's geometry. Ancient theories of vision explained perception as images formed in the eye like a reflection in a liquid mirror.[22] According to Diogenes of Apollonia the majority of philosophers viewed visual perception as "nothing other than the generation of pictures in the eye." Hence *emphasis,* the Greek word for the impression in the eye, is also the term used for reflections on smooth surfaces.[23] The only question was *how* the vi-

sual ray that was emitted from the eye reacted to the *eidola* (images) that it encountered in the external world.[24]

Seneca summed up the state of knowledge in his time when he wrote: "There are two opinions about mirrors: Some think that replicas are seen in mirrors; that is that the shape of our body has emanated and separated from our body. Others believe that there are no images inside the mirror but that the body itself is seen because eyesight is bent back and reflected on itself again."[25] The atomists believed, however, that when simulacra struck the surface of a mirror they rebounded back to the observer, as Françoise Frontisi-Ducroux has noted. The mirror turned the stream of images that objects sent out back upon themselves. If we follow Plato and the Stoics, visual rays struck a mirror like an extended antenna. "In one case one sees only images in a mirror, in the other case one sees the objects themselves. But in both cases what is valid for the mirror is also valid for the eye."[26]

The Greeks could never decide whether what they saw in a mirror was reality or only a deception, in other words, whether they were seeing bodies or only images.[27] Plato's *Timaeus* implies a theory of vision when Plato says that of all human organs, the gods made "light-bearing eyes" *(phosphora)* first. The eyes thus emit light rather than merely receiving it. The gods "caused the pure fire within us, which is akin to that of day, to flow through the eyes in a smooth and dense stream; and they compressed the whole substance, and especially the centre, of the eyes, so that they occluded all other fire that was coarser and allowed only this pure kind of fire to filter through. So whenever the stream of vision is surrounded by mid-day light, it flows out like unto like, and coalescing therewith it forms one kindred substance along the path of the eyes' vision."[28] The eye and the world of physical bodies stand in a mimetic relation to each other, because the eye is also a body and because it produces light.[29]

In Arabic optics, mirrors, with their surfaces of glass, were a medium of light and not a medium of the bodies that appeared in them. With mirrors observers could study the paths of light and their deflection; the images in them were of no concern and were not the source of scientific investigation. One could make a play on words and say that they were merely objects of speculation, and even grounds for mockery. Thus in the ninth century a boaster who provided no evidence for his hypotheses about how faces were formed in a mirror was mocked with the question of whether they were faces at all. He was not able to say whether images in mirrors were imaginary or not. Did they form on the surface of a mir-

ror, or perhaps in an entirely different place? In this anecdote images could not inspire fear because they were merely phantoms, and only a fraud would put forward scientific claims about them.[30]

In ancient times, however, mirrors had given rise to uncertainty and even fear. Standing before a mirror, people could experience their own existence as a riddle, and encountering their disembodied image confronted them with the thought of their own death. The example of Narcissus, who confused image and identity in the deceptive similarity of a watery reflection, aroused the fear of losing oneself in a picture (see Chapter 6). Plato spoke in the *Timaeus* of the images forming in mirrors, using the word *eidolon,* which could mean "idol" as well as "image" (46a). Before a mirror a person's own power of vision collided with the image that returns from the mirror. As Frontisi-Ducroux notes, the reflection that objects send toward us could cause people standing before a mirror to feel a sense of alienation from themselves.[31]

Euripides speaks of a "lifeless image" in a mirror *(apsychon eikon),* which resembles the person depicted so closely that only the voice is lacking.[32] The idea that there was "physical contact" between the eye and the object seen meant that light played only a secondary role. The reflection *(emphasis)* was the imprint *(typos)* that things left behind in the eye. Visual rays emitted by the eye also produced feelings of love and blinded the gaze like a stroke of lightning. In antiquity taboos and prohibitions related to the gaze document the fear of the "evil eye," which was considered to be an optical process just like falling in love. In vision as well as in other areas of life, human beings stood "in close physical contact with the world." "Strictly speaking one can say that seeing is a touch from a distance."[33]

The *presence of bodies* in the optical theories of antiquity led to a world of images, whereas the *presence of light* in Arab optics produced a de-iconization, so to speak, of the world in that culture. Reflection and refraction are of course optical facts, but they also stand symbolically for different worldviews. Reflection was of far greater significance than refraction in ancient optics, and that marks the difference between two visual cultures. Alhazen devoted the most attention to the process of refraction, in which no images are transmitted, and for him perception was just as dependent on the laws of refraction as was the path of light rays in mirrors. He considered his most important discovery to be the fact that "what vision perceives it perceives through refraction." This was "a fact which no one among the ancients noticed . . . [I]t is the manner of vision's perception of all visual objects."[34]

Pathways of Light and Properties of Objects

In the first book of his *Kitāb al-Manāzir,* or *Optics,* Alhazen introduces the pathways on which light travels. Light has a physical existence yet uses pathways that follow a geometrical course. This dualism links physics and mathematics. We see with our senses, which belong to our (corporeal) nature, but objects appear to us in a form, position, size, and motion in a manner that can be calculated mathematically (*Optics* I.1.2). This happens because our perception of all objects takes place according to the same laws, regardless of what the objects look like (I.2.5), on straight lines running between the surface of such objects and the surface of the eye. For this to occur an object must be opaque and of a certain minimal size, regardless of whether it is a body, a surface, or a line, since "the pupil of a mosquito's eye and similarly small things are not in any way perceptible by sight, even though they are existing bodies" (1.2.11). Furthermore, objects may not exceed a certain distance if they are still to be visible. Their visibility also depends on color and illumination; for example, ships with white sails remain visible at sea longer than those with dark sails. Alhazen distinguishes between the *properties of sight* (I.2 and I.8) and the *properties of objects* (II.3.44). "There exist many different distances which cannot be enumerated or determined" (I.2.22). Although visual perception is governed by light, we can recognize objects at a distance only on the basis of our experience.

The eye is a semitransparent body, but in contrast to lifeless bodies (objects) it has within it a light-sensitive organ that Alhazen calls the crystalline humor, or "the crystalline" (I.5.9), a term he adopted from the ancient Greek anatomists. Let us take a look at how he understood the structure of the eye (Fig. 36). The spherical crystalline *(B-B)* is concentric with the surface of the eye, or cornea *(A-A).* The visual cone *(c-d-e)* expands or contracts with the pupil and has its apex at the center of the eye *(d).* Within the area of the visual cone, rays strike the surface of the eye perpendicularly and in straight lines, but they are deflected outside the visual cone. The crystalline is sensitive only to those rays that strike its surface perpendicularly. Other rays are refracted. This occurs because "the transparency of the eye's coats is not the same as that of the air which is adjacent to the eye's surface" (I.6.19). "The forms that are simultaneously refracted to a single point on the crystalline are many and innumerable" (I.6.23). This is also true for rays that arrive from an object *(G)* outside the visual cone, since they are redirected at an

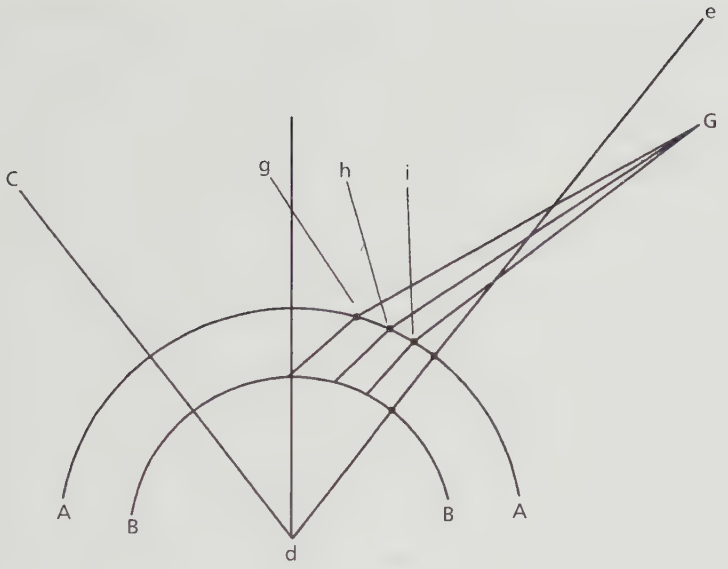


Figure 36: Illustration of Alhazen's theory of the refraction of light in the eye (drawing by Hans Belting, based on A. I. Sabra, "Ibn al-Haytham's Revolutionary Project in Optics," in The Enterprise of Science in Islam: New Perspectives, ed. J.-P. Hogendijk and A. I. Sabra, MIT Press, 2003, p. 100).

angle *(g-h-i)* between the eye and the object, so that they now arrive on a straight path and can be perceived by eye.

Extremely varied forms reach the human eye at the same time and all mix together, yet in an astonishing manner they are put back together in the same order that the actual objects themselves have. For Alhazen it is not sufficient to say that color and light are transmitted to the eye, since if that were all that occurred, it would mean the eye is capable of selecting visual impressions or mixing them in new ways. But that is unlikely, if only because the eye always perceives several objects and different colors. Hence Alhazen's argument runs that perception takes place as a series of points, according to the laws of refraction that cause the rays to be bent as they enter the eye (*Optics* I.6.10–17).

Newton's discoveries in optics were not yet available to Alhazen, so he had no knowledge of light waves and the effect they have on colors. He was limited to experiments that allowed him to observe how light travels. Not until the seventeenth century did scientists begin to investigate "the form and origin of light," as Francis Bacon had urged. Alhazen rejects the idea "that light is a body, but states that it requires a body (a medium) for its transmission."[35] "Air is a very transparent body . . . but has a little density in it," as can be seen when sunlight becomes visible in the atmosphere after the sun has set (*Optics* I.3.44–47). The straight lines along which light extends, he says in his *Discourse on Light,* are fictional and

not real.[36] The lines of the rays can be explained solely by mathematics, namely as a property of light, which *passes through* transparent materials and *illuminates* opaque materials.[37] Visibility is not a primary experience but rather one derived from light. The rays cannot be perceived directly, but they are responsible for our perception of objects.

All visible objects must be more opaque than the milieu in which we see them.[38] This theory is based on a worldview that is resistant to images or pictures, since by its very nature light is nonpictorial. We see it only when it is mixed with colors, which Alhazen already suspected existed in light: "The form of colour is always mixed with the form of light and not separate from it, and thus the sight cannot perceive light except as mingled with colour" (*Optics* I.6.3). Furthermore, when light radiates from transparent or opaque bodies, it appears as secondary and accidental light (I.3.88). Light passes through transparent bodies in a straight line, whereas it is deflected by the surfaces of opaque bodies. Only "heavenly bodies" possess pure transparency, while light is refracted by "earthly bodies" and its purity is weakened.[39]

As the light that self-luminous heavenly bodies emit travels, its strength diminishes.[40] Self-luminous bodies circle in the heavens, but in the earthly realm there are only transparent bodies (air), semitransparent, and opaque bodies. Everything is a body that is not light. As the world of bodies loses pure transparency, it also decreases in status. Only light has a different form of existence; in its motion and rays it is geometric in nature. Since light can be refracted, it cannot be stopped on its travels through the world when opaque bodies stand in its way. It is carried from the surface of objects through the transparent body of the air to the eye, "and that is what we wished to prove" (*Optics* I.6.60). With our sense of sight alone we can perceive "only the light and color in that object." All other properties of objects, such as size and shape, are recognized only in the visual center that lies in the brain, which Alhazen discusses in Book II of the *Optics*.

In his theory of the *reception* of visual impressions, which Alhazen develops in contrast to the ancient theory of emission from the eyes, the eye does not send out physical particles but rather receives visual forms from objects. This also offered the Arab author a solution to the puzzling question of how visible objects are properly perceived despite their various sizes and varying distances from the eye (*Optics* I.2.25). For the eye, their factual dissimilarity in terms of perception poses no obstacle to representation of them as "similar." In other words, light rays from objects create a *coherent* impression despite their actual *incoherence* in the eye.[41] Alhazen stresses repeatedly that vision does not occur "by means of a body

that goes out of the eye" (I.6.56) but that, conversely, forms of bodies enter the eye. Ptolemy had already known that visible objects are perceived only along the lines of the ray, "the straight lines whose extremities meet at the centre of the eye" (*Optics* I.6.43). The straight line is a geometrical concept, and "the view of those who take the radial lines to be imaginary lines is correct" (I.6.59). The existence of such rays can be deduced from their effect but not seen directly.[42]

Alhazen investigated the incidence of light at various times of day, when the sun was higher or lower in the sky, especially in the experiments using a "dark chamber" (see Fig. 34). From the way the secondary or reflected light behaved in the chamber he deduced its pathways and its refraction. The path and the refraction of the light were observed in their course through several chambers, which were not oriented toward any observer but rather arranged for investigating the laws that govern light. The reflections that appeared on the walls of the dark chamber were just as abstract and geometrical as light itself was in Alhazen's view.[43] Several of his devices have been reconstructed in Frankfurt, including a "reflective apparatus" with seven different mirrors. It was used to prove that the angle of the incident rays corresponded to the angle of the reflected rays.[44]

One device that was submersed in water served to measure the angle of the refraction of light *(in'itaf).*[45] A double chamber provided proof that accidental light also traveled in straight lines (Figs. 37 and 38).[46] The aperture in the outer chamber *(A)* was conical; the other aperture *(B)* was placed at a lower level so that a person in the inner chamber could see the sky. A straight line was drawn with a rope to point *C.* An experiment was begun during the night, before the first rays of sun entered the chamber. The sequence of spots of light allowed a straight line to be measured between them. The laws of nature could be discovered only through such inductive reasoning.

We can grasp the mentality of Alhazen better when we take a closer look at his terminology. In using the Arabic term *sūra,* which was rendered in Latin as *species* ("visual form," "shape," "outline"), he departed from the pictorial concepts of the Greek texts. The Arabic word means "form," or the representation of a visible object that enters the eye.[47] The term is also an attempt to reconcile the intrinsic properties of objects (size and material) with the properties of their perception (form). The word occurs in a number of applications in Alhazen's texts. Thus, the impressions that the brain or "last sentient" receives (after they have passed through the body of the crystalline and arrived at the "common nerve") are called "forms" (*Optics* I.6.82). He also speaks of "the two forms produced in the eyes" that "become one form before it is perceived by the last sentient," and so on.

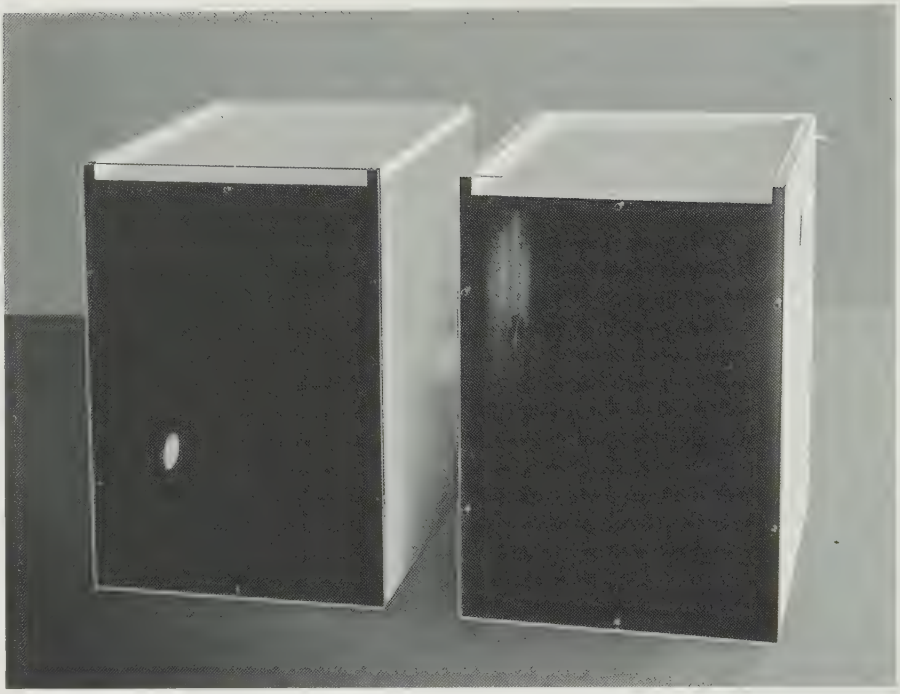


Figure 37: Reconstruction of Alhazen's double chamber for observing morning light, Institute for the History of Arab-Islamic Science, Frankfurt (Institut für Geschichte der Arabisch-Islamischen Wissenschaften).

(I.6.69) Again and again the *properties* that objects inherently possess turn into *forms,* as which they are subject to conditions such as distance and the position of the light source.

Khayāl, meaning the image of an object, is a term for such changing conditions. Thus, for example, "an object looks larger when it sinks deeper" in water. The angle of vision and distance can also alter it, so that the object appears larger or smaller than it actually is.[48] When light is refracted in water, the angle of vision changes at the same time. And when a layer of the atmosphere becomes denser as moisture collects above the horizon, this produces an alteration in the medium through which the rays of sight reach us. For this reason heavenly bodies appear smaller near the zenith than near the horizon, where the refraction of light is greater.

A third concept, *ma'ānī,* contains the root for "to mean" and includes both the (visible) properties of objects and the (mental) representations that we have of objects. The word usually appears in the plural, because we always perceive several properties of an object.[49] They are either inherent to the objects themselves, such as size, thickness, transparency, or number, or part of their appearance, as

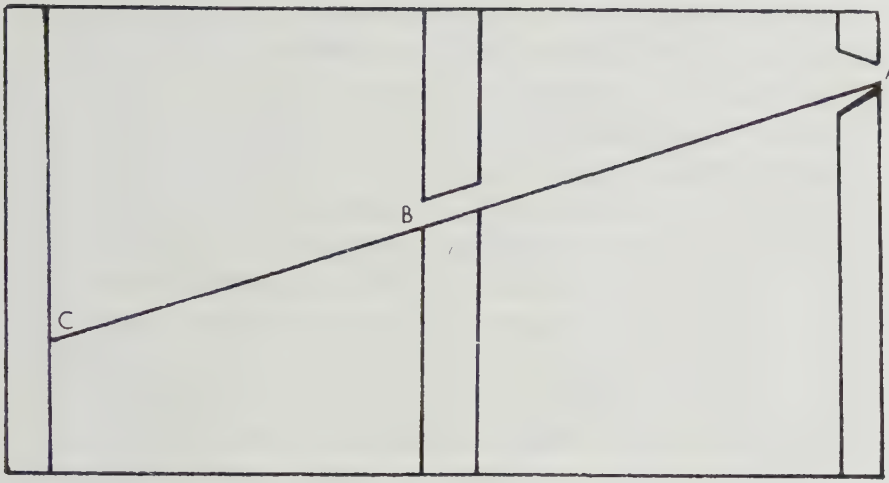


Figure 38: Alhazen's double chamber, as in Fig. 37 (after F. Sezgin and E. Neubauer, eds., Katalog der Instrumentensammlung des Instituts für Geschichte der Arabisch-Islamischen Wissenschaften: Geographie, Nautik, Uhren, Geometrie, Optik, Institute for the History of Arab-Islamic Science at the Wolfgang Goethe University, 2003, p. 178).

light, color, distance, angle of vision, and motion or rest. Since they are mostly of an accidental nature, they do not describe the essence of objects. In every new situation they present a different appearance, and therefore the eye and the soul must work together if we are to acquire a conception of the essence of things. Arabic philosophers use the term *ma'ānī* in explaining that colors, which belong to a universe of their own, always occur separately and accidentally in every object. The context always determines how *ma'ānī* are to be understood. In poetry the term denotes the sequence of words in a verse; in visual experience it denotes the appearance of objects, which is affected by their location, their distance, and light. What we experience as we perceive things is only their effect.

The laws of optics had validity solely in the external world, however. What we today would call the synthesis of a visual image no longer fell within the province of optical science, since visibility (in the eye) and visuality (in the brain) were separate processes. The former was a field of optical theory, but the latter topic, to which Alhazen devoted the second book of his chief work, belonged to the realm of psychology. He opened this book with an empirical investigation of the process of seeing as it unfolds in time. Our eyes move with the visual rays, scanning objects as if with antennae or feelers. Imagination is required, however, to integrate their separate properties into a "picture." Only in the imagination is the "shape" established that becomes fixed in the soul (*Optics* II.4.22). Alhazen observes that "sight perceives visible objects in two ways: by glancing and by contemplation" (II.4.5); "vision by mere glancing is vision of objects which sight neither recognizes nor contemplates at the moment of noticing them" (II.4.33). We

perceive "the quiddity of an object" only through contemplation or an act of mental appropriation in which we supplement what the eye actually sees with prior knowledge of the object (II.4.22 and II.4.33–34).

Since our perception subjects us to constantly changing appearances, we must fall back on the ideas or representations of objects that we have previously formed. In the process, our outward senses function in conjunction with the inner workings of our mind. Thus, Alhazen observes, our sight does not actually perceive the dome of the heavens but only "a certain blue color."[50] Likewise, forms appear flat to us whenever they are too distant for our sight to reach. The images that we have of objects originate only in a process of mental synthesis. If we stand facing a wall and hold a hand up in front of our eyes, the portion of wall screened by our hand is larger than the hand itself. This occurs because the angle of vision is the same for both. A mental act is required for us to become aware of the illusion.[51]

Alhazen's "aesthetics," as some scholars refer to his theory of beauty, cannot be separated from his theory of perception, since it belongs to the part of his work in which he argues in psychological terms and shifts into the realm of mental actions. Beauty or ugliness also numbers among the properties, or *ma'ānī,* of objects. But here Alhazen is guided by norms specific to his culture. This is shown by the examples from textile art and decorations on walls and artifacts, where light and color dominate over corporeality and space. "The sun, the moon, and the stars look beautiful, without there being in them a cause on account of which their form looks beautiful and appealing other than their radiant light. Therefore, light by itself produces beauty" (*Optics* II.3.202).[52] Colors produce beauty as well, since all bright colors "such as purple, . . . vegetable-green, rose . . . and the like, appeal to the beholder and please the eye. Similarly, dyed clothes and decorated objects, also flowers, blossoms, and meadows are felt to be beautiful. Therefore color by itself produces beauty" (II.3.203). Furthermore magnitude belongs to the appearance of beauty, and "that is why the moon is more beautiful than any one of the stars" (II.3.208). A sense for beauty is inherent in the soul, and even children display it, for they possess the ability "to distinguish between two objects of the same kind in terms of their beauty."[53]

Impressions of beauty arise from comparisons made in the act of seeing. The faculty of judgment *(al-quwwa almumayyiza)* is responsible for this, a term that was translated into Latin as *virtus distinctiva* (*Optics* II.2.25).[54] The images created by our powers of imagination have no counterpart in the external world, even if it is stimulation from that world that produces them. The true nature of objects is

perceived only when visual scrutiny is followed by contemplation. Such perception goes beyond the sense of sight alone, since it draws upon memory. "The contemplation by which the true forms of visible objects are perceived is performed by the eye itself and by judgment" (II.4.6). The mind discerns the properties of an object by comparing them with similar properties of objects already known (II.4.11). Often only a few properties, or even only a single one, are sufficient for identification of a visual object; we can recognize a human being, for example, just from seeing the outline of a hand (II.4.21). Furthermore, since all visible objects in the world of generation and decay are susceptible to change, it is by no means certain that on seeing a previously seen object for a second time, we perceive it in exactly the same way we did the first time (II.4.32). People must encounter a particular kind of object repeatedly before they can fix what Alhazen calls the "universal form" of it in their mind (II.416).

We experience the world like a broadcast signal. Our "sensorium" is responsible for this, either through innate abilities or those that have been acquired through practice. It enables us to filter out the accidental conditions affecting perception and to apply principles of proportion and harmony. This is how we create order among different "figures" of one and the same object. This order consists of arrangement, bearing, position, and rhythm. Alhazen always speaks of "figures" in the plural, because objects have many properties. These function as distinguishing marks by which we can identify the objects again. Patterns of lines, colors, and concave or convex surfaces also number among properties of this kind. *Al-nuqûsh*—another plural form, of course—are decorative "figures" in which "the sense for adornment replaces the mimetic sense of art."[55] This is why walls or implements are adorned with little dots and ornamental figures or patterns. *Al-nuqûsh* is a key term, for it "denotes forms that embellish objects and bodies, in contrast to properties that deform them and decrease the value of their appearance."[56]

In Islamic art animals and plants usually have a decorative character when they appear on objects such as bowls or buildings, and Alhazen describes them as adornment on surfaces. Yet their lifelike depiction prompts him to ask why we still perceive them as animals and plants and not merely as decoration. How does it come about that painting and textile art, which work with flat surfaces and hence are so utterly different from nature, can still reproduce natural forms? In Book III of his *Optics* Alhazen counts art among the deceptions to which our perceptive apparatus is exposed. How can artists succeed in giving their work a

similarity to nature that is, strictly speaking, impossible? Alhazen concludes it is possible only because when we see anything in daily life we constantly make mental comparisons.

We are also susceptible to constant deception and illusion in phenomena in nature and for that reason have developed the ability to transform differences between art and reality into similarities. Artists' figures resemble animals and plants despite the fact that they occur on flat surfaces, Alhazen observes, because the painters use color and draw lines with great skill, "paying particular attention to points of resemblance." By this he means artists can create deceptively realistic-looking hairy animals or fuzzy plants, even though their pictures are "flat and smooth or even polished" (III.7.39). Painters are nevertheless dependent on our imagination, which enables us through silent contemplation to find similarities in dissimilar things. In life, too, we represent faraway objects to ourselves with all the properties that we cannot actually discern from a distance. Alhazen can relate art and reality to each other in the act of seeing only because he has couched his argument in psychological terms. It is significant that when speaking of art he observes only surfaces, just as when discussing objects he speaks of their surfaces, which are linked point by point with the surfaces in the eye.

Arabic script serves Alhazen as a further example in explaining his theory of perception, and he stresses the geometric system of writing (see Fig. 24) that developed during his own lifetime in the "proportionate" style of the Baghdad school (see p. 113). *Reading* and looking are both acts of perception. In Alhazen's concept, people perceive the visible world as readers. The fact that the world is visible means it can be decoded by means of a grammar that we practice all our lives with our sense of sight, and this causes him to develop his own theory of signs: We take single signs or properties of objects and transform them into internal images that have no equivalent at all in the external world. Signs are described in Book II of the *Optics* as properties of things: Perception occurs "through prior knowledge and signs." We learn to grasp "what the object is as a whole" because our mind recognizes its particular properties. This is why we can recognize objects whose appearance has changed. Unless we examine such objects or persons closely, we perceive them as they were when we saw them for the first time (II.4.29–30).

The key question in our context is: How is the cross section of the *visual cone* within the eye, as described by Alhazen, related to the plane that intersects the *visual pyramid* in linear perspective paintings? Abdelhamid Sabra speaks of them as analogous, since Alhazen's theory of vision was "image- or picture-oriented."[57]

But what kind of pictures were they? I would like to raise an objection here: Sabra himself distinguishes the spherical surface of the visual cone from the flat surface of a painting in linear perspective. Yet the crucial difference lies in the fact that the cross section through the visual rays in a perspective painting is located *in front of the eyes* and not within the eye. Imagining something and placing it before one's eyes merge into one, in this instance. The perspective painting is an artifact in which the barrier between outside and inside seems to have been abolished; this barrier was insuperable for Alhazen, however, and thus he was forced to place the visual image behind the eye and to explain it in psychological terms. He has no conception of a *picture* between the eye and an object, nor is he familiar with the empty *space with coordinates* on which Renaissance paintings rely. In his world of objects there exist only air, water, and glass, which transmit or refract rays of light in different ways. The only active force in the world is light, which is not bound by any spatial laws and has no pictures. "Seeing" means something utterly different in the two cultures. Since images were understood in Arab culture to be purely mental ones, they could not be copied or depicted as analogues of nature in physical artifacts.

Mathematics and Geometry in Islamic Art

Until now scholars have too quickly filed Alhazen away in the category "history of science" or limited themselves to studying his aesthetics, whereas little attention has been paid to the influence of his native culture on his mathematics.[58] Yet his geometry of rays can be "read" or interpreted outside the framework of his theory of vision as well as within it. Only in Arab culture was it possible to construct such a disembodied and geometrical way of seeing, representing a complete contrast to the conceptions of Greek antiquity. The belief that mathematics and physics can be combined without difficulty because the world itself has such a twofold aspect, also points to this same cultural background. Mathematics became an omnipresent code in Arab art. As geometry, it became in Alhazen's day a concern of art in its own right, whereas in Renaissance art geometry served as the basis for paintings whose theme was the world of the senses. We can thus speak of geometry being *represented* in Islamic art; geometry as a representation of cosmic laws and not merely decoration or a technique. It stands in contrast to the repre-

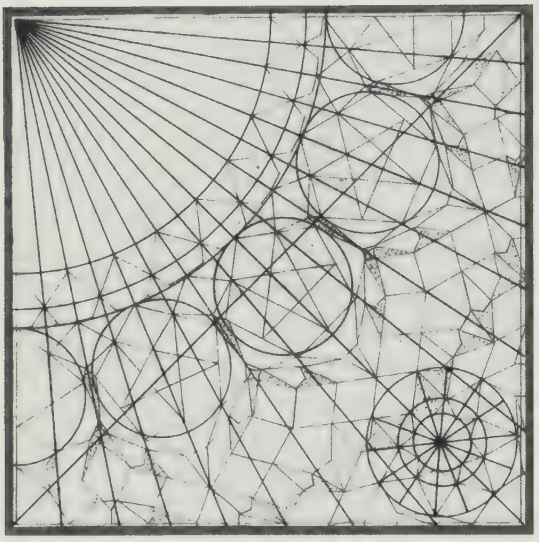


Figure 39: Detail of a scroll with architectural drawings, Iran, ca. 1500, Topkapi Palace Museum, Istanbul (after Gülru Necipoğlu, The Topkapi Scroll, Getty Center for the History of Art and the Humanities, 1995).

sentational geometry of Western art, as a method for *representing* or creating lifelike images.

Consequently it makes sense that Alhazen chooses a geometrical figure to explain how perception operates. Western readers, in contrast, will expect representational images for explaining how perception works. For Alhazen perception occurs in two steps, first as an optical process and then as a mental one. He discusses in minute detail the figure of a polygon inscribed within a circle—a topos of Arab geometry, as the drawings of the Topkapi scroll prove (Fig. 39). "When sight perceives a circular figure in which is inscribed a polygonal figure . . . it will immediately upon perceiving the general figure perceive it to be circular, but will not at once perceive the inscribed polygon if its sides are extremely small . . . But when the polygonal figure is perceived the inequality of its sides will not be immediately apparent . . . the inequality . . . will only become apparent . . . after a sizable interval of time" (*Optics* II.4. 27). Alhazen devotes as much attention to the construction of geometrical forms (and the complementary process of their decoding by an observer) as Westerners do to paintings with complex iconography. He even encourages his readers to "read" geometrical figures step by step, as they would a piece of writing.

This also helps us to understand why the process of reading serves as a further example for how perception works. Western readers are likely to be all the more surprised, because of the fact that in their own culture reading and seeing are kept as separate categories in the same way that signs (writing) and pictures (images) are. On Islamic buildings, however, script and ornament are combined or joined into two complex and complementary systems based on geometrical principles. The "brick style" represents an exemplary technique developed to construct both Arabic letters and ornamental elements out of tiles and relate the two to each other. Ornament and script may also enter into a symbiosis on carved stone walls, producing a final effect in which the two can hardly be distinguished from each other. On a facade from the Seljuk period in the city of Konya, Turkey, bands of free ornament are paired with bands of text from the Koran in a script made up of

similar knots and loops (Fig. 40). To read the facade, speaking in Alhazen's terms, first of all we need to decide what is script and what is free decoration ("free" in the sense of not consisting of letters, but not free of meaning), since the script is just as geometric in form as the ornamentation. In turn the ornament is not simply embellishment, as in Western art, but a semantic medium like the script, carrying a message that cannot be deciphered without prior practice in the culture. In other words, training the eye and the mind is a way to learn the plan on which the world is constructed, a plan that the Creator encoded in a variety of ways.

Arabic calligraphy and its tendency toward abstract order bring us particularly close to Alhazen's obsession with geometry (see Fig. 22). Just as points of light connect to make "forms" in the eye, so too letters are connected to make words in the act of reading. "Beautiful writing . . . is regarded as such because of order alone. For the beauty of writing is due only to the soundness of the shapes of letters and their composition among themselves, so that when the composition and order of the letters is not regular and proportionate the writing will not be beautiful, even though the shapes of individual letters may be correct and sound" (*Optics,* II.3.205). Thus the eyes—and with them the mind—learn to understand entire words without having to read the letters one at a time. When someone skilled in writing sees the form of a word, he will perceive what word it is from its total form, "before inspecting the letters in this word one by one. And so it is with all words repeatedly presented to scribes: they are recognized . . . at the moment of their being perceived before every one of their letters has been inspected" (II.4.21). This is prior knowledge, experience, practice, recollection.

The boundaries to free ornament were fluid, since the phonetic signs were stylized like the fundamental elements of every kind of ornament. "Legibility" also applied to decoration with a complex structure, for which a key was needed. Ibn Muqlah (836—939) used modules in the form of rhombus-shaped dots and standardized each letter "in proportional relation to the straight line of the *alif.*"[59] The "proportioned script," as the reform of Arabic writing in Alhazen's era is known, was based entirely on a geometrical order. Alhazen uses the term in the literal sense (*Optics* II.3.229). In his time a canon of writing was developed that would become authoritative for the entire Islamic world. Geometry also gave the text of the Koran an appearance similar to the forms of ornamentation that spread all over the Arab world (see Fig. 24).

Alhazen's theory of vision, therefore, originated in the same cultural milieu in which the physical appearance of architecture and art was dominated by mathematics. The same worldview underlay science and art. Ornamentation functions

as the visible counterpart to Alhazen's calculations of the geometry of rays in the field of optics, and much the same applies to his view of light and color. They are used in the art of his era not to illuminate objects in pictures, as was the case in the Renaissance; rather, they operate as independent themes in art, contrary to Western standards. In his experiments in dark chambers Alhazen observed the pathways followed by rays of light and the reflection of color without seeking images in the physical world. His theory is based on a perceptual practice that was culturally influenced and therefore differed from that of the Greeks.

Early on, Islamic ornamentation diverged radically from ancient patterns. In the Dome of the Rock in Jerusalem (see p. 60) the calligraphy was just as decorative as the stylized plants, which have not yet lost all resemblance to their fleshy models from classical times (see Fig. 20). The local artisans who installed these mosaics accepted without compromise a new aesthetic that was not their own. The repetition of the motifs subject the individual forms to a strict principle. The *surfaces* of the plants and vases merge with the *surfaces of the walls* in which they are embedded, while the main role is taken over by the reflected daylight in the interior.[60] Not until three centuries later, namely during Alhazen's lifetime, did this process come to a climax; by then Islamic ornamentation had become entirely disembodied and so geometrical that a supraregional canon of elements had come into existence.

Figure 40: Detail of text from the Koran on the facade of a madrasa in Konya, Turkey, ca. 1260–1261 (FMR Magazine).

The geometrical style to which the Renaissance later gave the name "arabesque" (see p. 39) developed around 1000 CE at the court in Baghdad. During the flowering of the "Sunni revival" it soon became known as the "*girih* mode"—from the Persian word for "knot"—that was still familiar to Albrecht Dürer as the "knot style" (p. 39). To compensate for the exclusion of figural representation in this culture, artists had to formulate "nonfigural modes of representation that relied on a vocabulary of inanimate forms."[61] The canonical (proportionate) script and the new knot style—both inventions of this same period—made use of mathematical knowledge that was disseminated in popular handbooks. They contained "what the artisan needs to know of geometric constructions," according to Abu al-Wafa' al Buzjani (940–998), the author of a manual of practical geometry.[62] Mathematical textbooks of this kind were also used by builders in Iran in the eleventh century for constructing buildings in the "brick style," with the result that such buildings had a similar appearance everywhere.[63]

The *girih* style of Abbasid culture, with its linear structures covering entire surfaces (strapwork) purifies the eye, removing impressions of the bodily world, much as Alhazen's mathematical theory cleansed the anthropomorphic notions

from ancient optics. Several authors of his era appropriately compare this form of ornamentation with soap, which removes stains from clothing; thus was human sight supposed to be purified of too much sensuality and lust by means of geometry.[64] Beams of light serve as an organizing principle in interiors in the same way that patterns of lines function on the walls. Such disembodied arrangements seem to make the walls and limits of the space disappear, an effect brought about by the dominance of light and pattern over all material substance.[65] On the shimmering walls of the Imam Reza shrine (Iran, thirteenth century) the reflected light overwhelms and almost obliterates the material substance of the structure (Fig. 41). Whether in primary or secondary form, light celebrates a kind of epiphany in Islamic architecture, perhaps recalling Alhazen's dark chambers, in which the primary light of the external world persists as a beam of reflected light (see p. 105). In Islamic interiors primary light is filtered and reflected many times as well, so that its effect is increased. In fact the interior walls reflect the light differently as the sun progresses overhead, in the same rhythm that occurred in Alhazen's experiments.

One can speak of a cosmic spectacle that is presented in Islamic interiors: In a manner of speaking the *girih* pattern makes a dome rotate, thereby representing the vault of heaven as it turns. In this manner one of the domes in the Alhambra symbolizes the daily path of sunlight and the changing picture of the stars (Fig. 42). Verses by the Andalusian poet Ibn Zamrak (1333–1393) running around the base of the vault confirm that such an interpretation is correct:

> In here is a cupola which by its height
> becomes lost from sight; beauty in it
> appears both concealed and visible . . .
> And how many arches rise up in its vault
> supported by columns which at night are
> embellished by light!
> You would think that they are heavenly spheres . . .
> When they are illuminated by the rays of
> the sun you would think that they are
> made of pearls by reason of the quantity of celestial bodies in them.[66]

The surface of the vault, consisting of many layers of *muqarnas* with their "rough" skin, as Alhazen would say, is a medium and a filter for the entering sunlight, which changes from hour to hour (see p. 204). The vibration simulated by the fixed and unmoving surface of the wall creates an impression of movement that

Figure 41: Interior of the Imam Reza shrine, Mashhad, Iran, thirteenth century (© Roger Woods / CORBIS).

symbolizes the motion of the cosmos. On the mathematically complex *muqarnas* a spatial geometry traverses the surface, which is otherwise its matrix, and filters the thousandfold reflected light on spherical zones. Spanish mathematicians today can prove that the entire decoration of the Alhambra, whether on the floors or walls, has concealed within it original solutions for mathematical problems.[67] Its beauty is not meant for the eyes alone, since it has additional appeal as a secret key to mathematical equations.

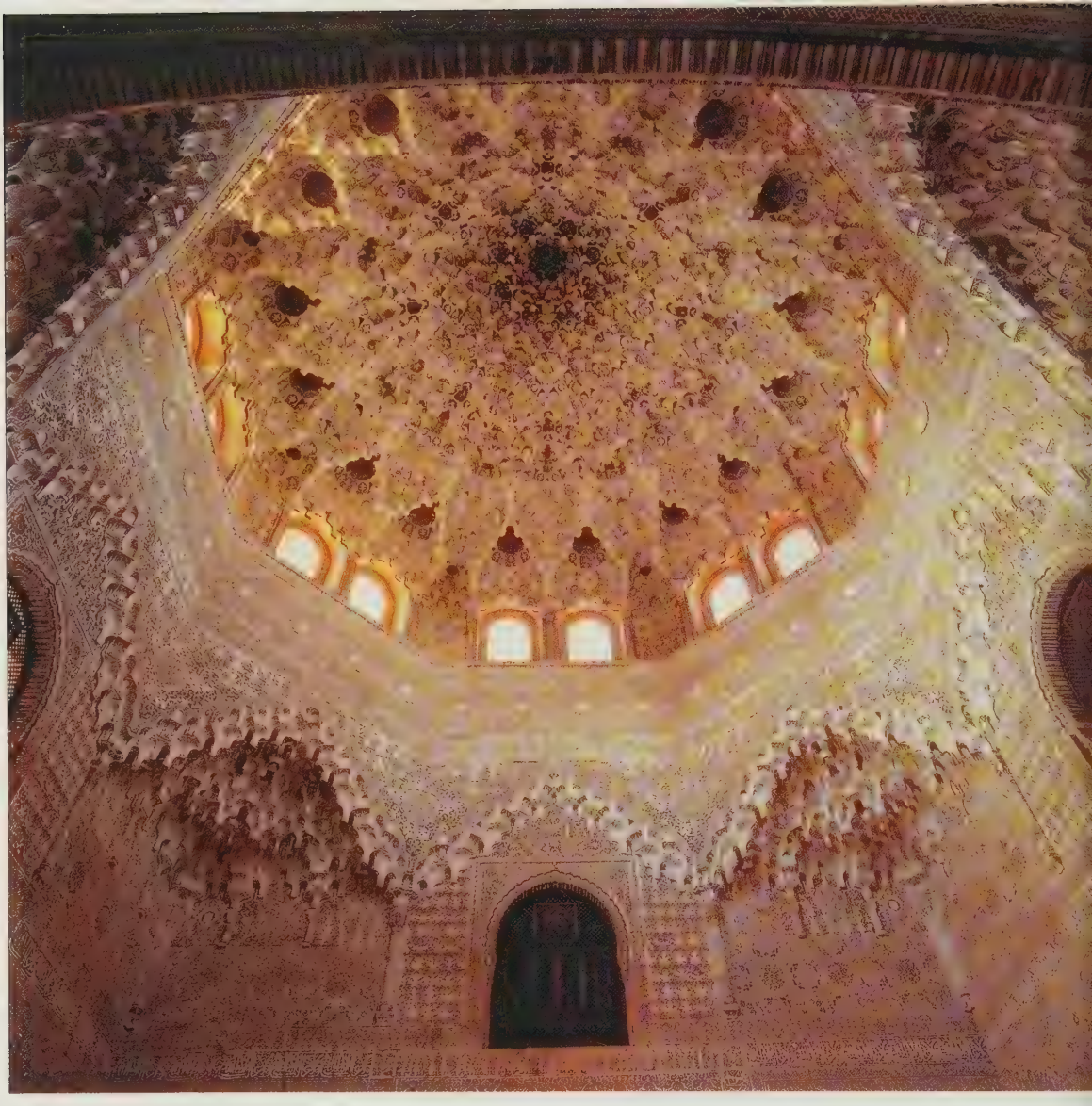


Figure 42: Vaulted ceiling of the Hall of the Two Sisters, the Alhambra, Granada, Spain, ca. 1230 (Bridgeman Art Library).

Oleg Grabar has referred to ornament in Islam as mediation, and the philosophical question now arises as to how this term should be understood. What comes to mind first is understanding ornament as distinct from "representation" and "image" and explaining it as their opposite. But what is being mediated here? That is more difficult to explain than the form with which this mediation is working. Is there something in ornament that points beyond ornament? In *girih* patterns, surfaces are organized with rays, circles, and polygons so that the geometrical "figures," primarily as lines, extend outward or their sides meet, neatly filling

the surface area. In *muqarnas,* light is caught in strict patterns and reflected, and the different colors become subordinate to the geometrical order. All this presents itself as order of an abstract kind not limited to the interplay of lines and fields. It seems that it inspires silent "contemplation," to use Alhazen's term, and turns an observer's thoughts inward. Already in the early culture of Samarra the "beveled style . . . has obliterated the originally vegetal nature of the units of decoration."[68] Later the bright or shaded empty forms create a second pattern in the gaps of the visible pattern, acting as both a contrast and a complementary form. Light, too, forms patterns of its own when it enters a room through the kind of latticework window called a *mashrabiyya* (see Fig. 105 and p. 252).

Before continuing the discussion, we should perhaps take a look at how Alhazen describes Arab art when he uses it as an example. His gaze is always drawn to ornamental designs, yet he speaks of them as if they did not exist on a material object. He especially likes to use textiles or other surfaces with colored figures *(al-nuqûsh)* to explain how colors change with the light, or he takes a pattern with dots to illustrate how objects emit points of light that reach the inner surface of the eye. Physics and mathematics—two disciplines that Alhazen wished to reconcile with each other—also have a twofold presence in Arab art. Buildings and objects have an inherently physical existence, for they are constructed, thrown on a potter's wheel, or, in the case of textiles, woven. And yet by mathematical calculation they become subordinated to a geometrical pattern that is no longer solid and corporeal but instead tends to dematerialize what it adorns. The immediately visible surface design overlays, like a lattice or veil, the objects and structures on which it has been placed. Whereas the medium, be it a building or an artisan's handiwork, is of a physical nature, the ornamentation is a locus of mathematics that is situated in the physical world even if it has been produced by art. Mathematics here has its place in physics.

We encounter this dualistic (both sensory and abstract) conception of visibility again in Alhazen's theory of light rays. His geometry of light is not directly visible—in contrast to light itself—but it makes the world visible for us. The pathways traveled by light can be recognized only by their effect, but they can be depicted symbolically, namely in the language of geometrical figures, which are calculated according to the same mathematical laws as light. Geometrical decoration dissolves material surfaces into layered multicolored designs that acquire an autonomous existence and, one could argue, suggest the activity of light in a physical world. The order of these patterns resists the senses, for it represents a reality that can be made visible only as a principle of construction. It activates the mental process that Alhazen separates from optical processes and assigns to the

imagination. It is to this latter function, called the "last sentient" in his theory of perception, that mathematical decoration is addressed.

The hidden mirroring character in the symmetries of geometrical ornament also point to light, which reveals its pathways and angles in mirrors. Mathematicians like José Montesinos (see p. 206) speak of such patterns having an axis of reflection. Both reflection and refraction are projected onto a surface in geometrical decoration and must be depicted there in two dimensions. The problem that Arab mathematicians had to solve consisted in the fact that only a limited number of variations of rotation and symmetry can exist on a surface. The triangular and hexagonal patterns that have repeatedly attracted the attention of modern mathematicians are affected by this. In 1879 the Frenchman Jules Bourgoin published drawings of many Arab designs, whose mathematical calculations fascinated him.[69] The Danish scientist Emil Makovicky published a paper in 1977 on their significance for the field of crystallography. The designs, he found, bore a surprising similarity to projections of crystal structures that can be divided into periods of two, three, four, and six.[70]

Peter Lu and Paul Steinhardt, two American physicists, recently caused a stir with their discovery that as early as 1500 CE Islamic design included quasi-crystalline Penrose patterns, whose structure became known in the West only in the twentieth century.[71] The discussion here will remain limited to *girih* tiles, however, which occurred earlier and consist of a set of five equilateral polygons that can be combined in complex periodical patterns (Fig. 43F). When these tiles are joined together, all the lines that run across one tile are continued on the neighboring tiles, so that the entire field is covered by an allover network with its own periods and symmetries. The five shapes of the *girih* tiles, which are hidden under the pattern of lines, do not become recognizable until they are colored in, as Lu and Steinhardt did in their illustration (Fig. 43G).

Each edge of the five equilateral polygons in Figure 43F is the same length, and two decorating lines intersect the midpoint of every edge at 72-degree and 108-degree angles. If two tiles are laid edge to edge, then decorating lines will continue across the common boundary without changing direction. The line intersections and tiles contain only angles that are multiples of 36 degrees, and so all decorating-line segments in the final pattern will run parallel to the sides of the regular pentagon. Thus any combination of *girih* patterns will always result in decagonal geometry.[72] Lu and Steinhardt demonstrate the principle as shown on an octagonal mausoleum from the twelfth century in Iran. The building is an example of the brick style mentioned above, and the structure of the bricks perfectly matches the *girih* pattern that continues across every adjacent field, with new and

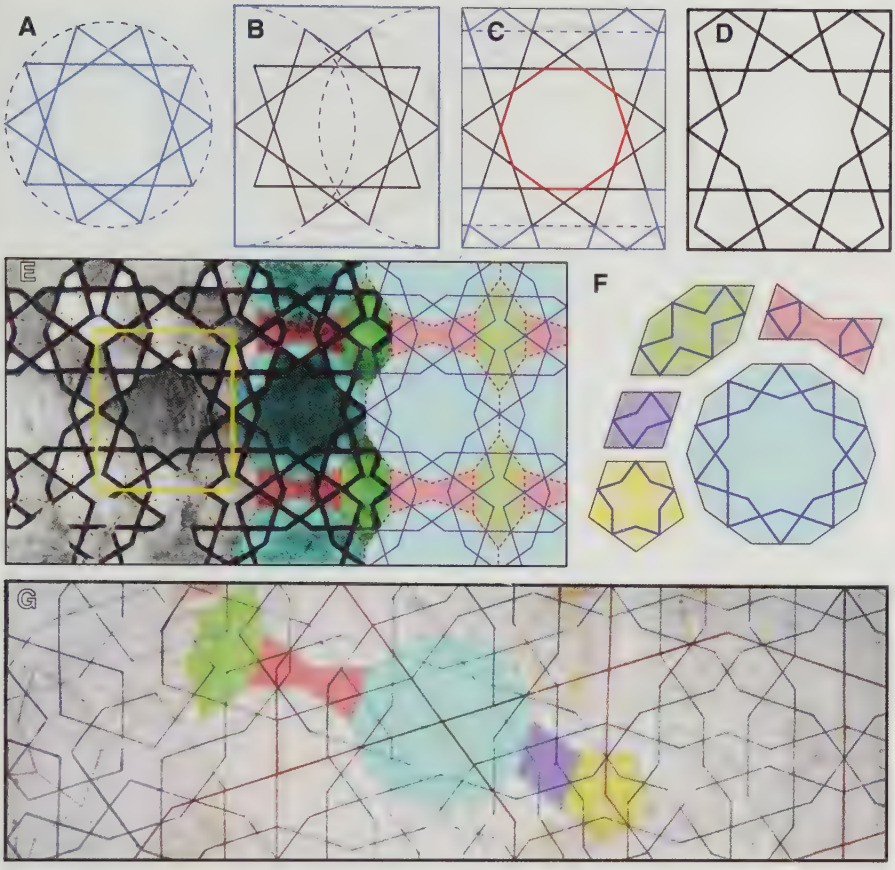


Figure 43: Girih tiles after Peter Lu and Paul Steinhardt: Diagrams A to D show how one of the tile patterns is generated; E shows a detail from the shrine of Khwaja Abdullah Ansari at Gazargah (Afghanistan), with the pattern from D highlighted inside the yellow rectangle; as one can see on the right, the same pattern can be achieved by joining the five different girih tile shapes from diagram F together; diagram G shows a section from a scroll of architectural drawings (now in the Topkapi Palace Museum, Istanbul) in which these five basic shapes were used (Peter J. Lu and Paul J. Steinhardt, "Decagonal and Quasi-Crystalline Tilings in Medieval Islamic Architecture," Science 315 [February 2007]: 1106–1110).

surprising symmetries that disguise the edges of the structure's eight sides so thoroughly that they appear to make a flat surface (Fig. 44).

The two authors found a rich trove of such designs in a scroll containing 114 architectural drawings that originated in an Iranian milieu around 1500 CE and is now in the Topkapi Museum in Istanbul (see p. 206).[3] The drawings do not depict buildings but rather patterns that could be used by artisans for walls and vaulted ceilings (Fig. 45). The repertoire of geometrical forms contained in them are so universal that they are not bound to any particular architectural style or dimensions. With the aid of these models, architects could design geometrical decorations with patterns so complex that they exceeded solutions known to contemporary mathematicians. The majority of the designs were intended for *muqarnas* (see p. 204), which were especially complex and constituted a special area of mathematics (see Figs. 80–83). The translation into three-dimensional forms remained largely speculative. Alhazen draws on patterns of this kind as examples

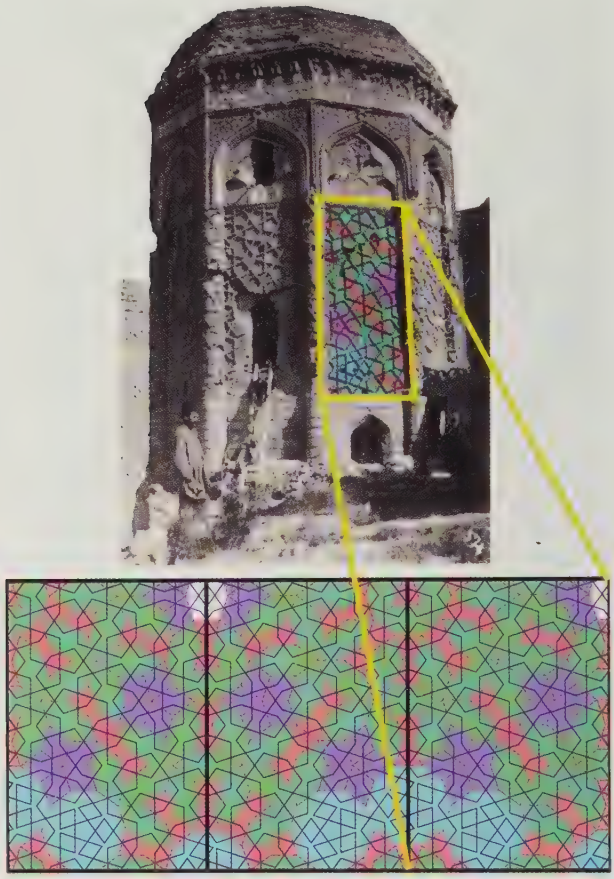


Figure 44:
A mausoleum in Maragha, Iran, ca. 1197, with a colored reconstruction of the pattern of girih tiles by Peter Lu and Paul Steinhardt (Harvard College Library / Peter Lu: original photo courtesy of Special Collections, Fine Arts Library, Harvard College Library).

when he explains the mental process of perception (see Fig. 39). In one drawing on the Topkapi scroll there is a design resembling a mosaic in which the color is subordinate to the geometry and becomes a kind of counterpoint. As projections onto a flat surface, these drawings seem similar to pictures in Western perspective insofar as they are projections, too, but the intention is a very different one. In the Renaissance, the intent was to simulate a visual image that is linked to an individual gaze and related to the point at which an observer is standing. The surface is interpreted quite differently as well. In the Renaissance it is the medium by which a space appears in a painting, and an observer looks through it. In Arab culture the surface has a positive meaning attached to it, for it is the locus where a geometry of cosmic significance is mathematically calculated and depicted.

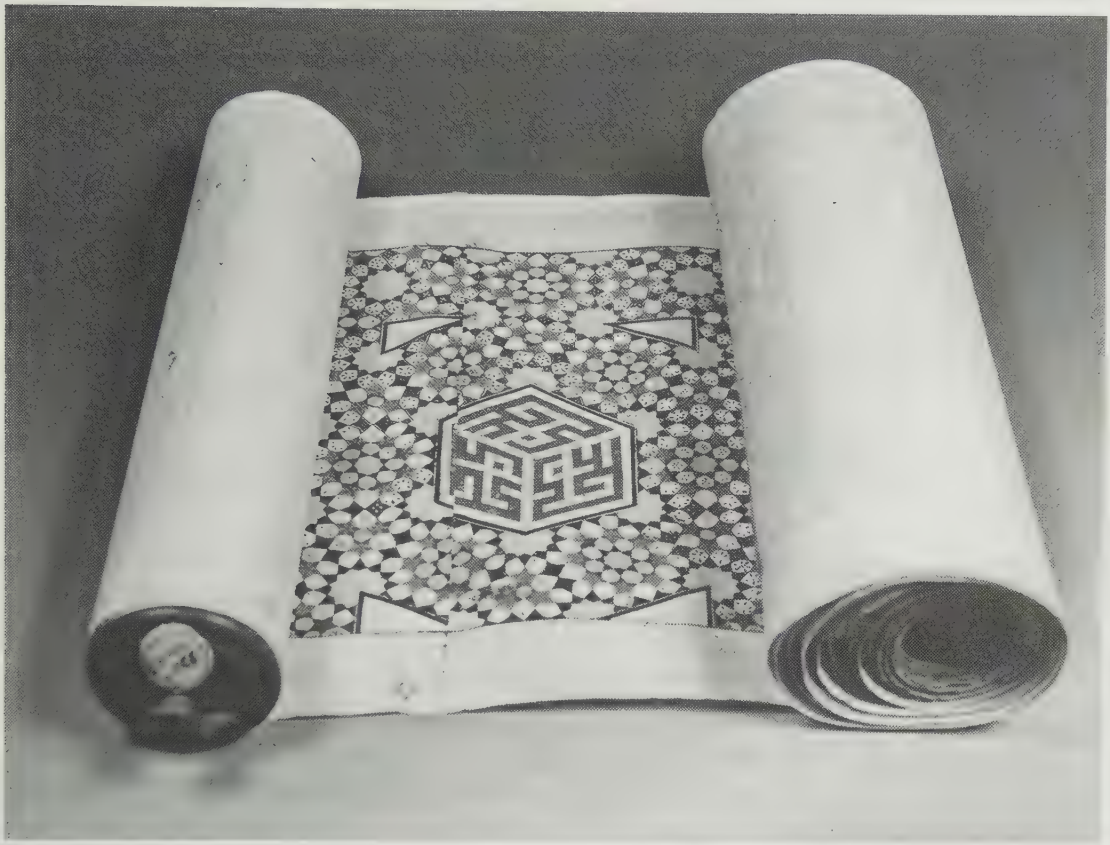


Figure 45: Scroll with architectural drawings, Iran, ca. 1500 (Topkapi Palace Museum, Istanbul).

Every culture impresses a particular mindset on its members by how it treats the gaze—as privileged or taboo—and is itself stamped in turn by norms and prohibitions related to the gaze. Even scholarly theories are linked to local cultural rules. It was a particular worldview that enabled Arab scholars to transcend the Greco-Roman concept of vision that they had learned from ancient texts. In the synthesis of physics and mathematics they dematerialized the ancient models of vision and created the foundations for the calculation or calculability of the process of seeing. Yet it all came together in images only when mathematicians in Western culture introduced the notion of empty space. Hence the pictures of the Renaissance are completely different from those of antiquity (and we cannot speak of pictures at all in Arab culture), as they are constructions based on mathematics. Only on this foundation could the visual culture of the early modern period become pictorial again, but in another sense than in antiquity.

Blickwechsel: Kepler Rediscovers the Camera Obscura

The camera obscura, an Arab invention, was rediscovered in the West during the Renaissance, but the focus lay elsewhere. When Alhazen's theory was put to the test in the seventeenth century, Europeans were seeking a model to demonstrate how the process of vision functioned. By this time knowledge of the eye's anatomy had improved and scientists had discovered the existence of the lens. It was no longer possible to account for perspective images with Euclid's visual pyramid, since it was now known that the physiological image on the retina was laterally transposed and upside down, exactly like images in the "dark chamber." The analogy between eye and camera obscura was so close—with the exception of the curvature of the eye—that the latter could serve as a model for eyesight, just as Alhazen had presumed (see p. 96). Furthermore it was possible to "retrofit" a camera obscura, so to speak, with a lens like the one that had recently been discovered in the eye.[74]

This abruptly reversed the relationship between images and the eye: Whereas the perspective painting wanted to project the human visual image outward, the camera obscura brought it back from the external world into the interior of the eye. Kepler refers to the retina as a wall and observes that "the arsenal of the optical writers does not extend beyond this opaque wall." The process by which vision occurs produces mechanically an image [*eidolum seu picturam*] "at the white wall, tinged with red, of the concave surface of the retina." On this surface an image of a thing is "depicted" [*impingitur*] before it impresses itself on the brain, for "no optical image [*imaginem opticam*] carries through" past the joining of the optical nerves. As Alhazen already knew, optics alone cannot explain how "vision occurs through this impression of images upon the spirits," meaning the visual part of the brain. Rather, "the visual faculty, like a magistrate [*quaestor*] given by the soul" goes forth to the retina to meet this image.[75]

At this point the scientific authority of perspective images was rejected, and a painting using this technique could no longer be considered an accurate facsimile of a visual image. Kepler negates any analogy between the image on the retina and the plane of such a painted picture, noting that perspective had prevented him from recognizing the apparent curvature in the paths of heavenly bodies: The retinal image could no longer be equated with the plane of painting *(super plano picturae).* "Our sense of vision possesses no surface such as a painting has" *(nul-*

lum planun pro tabella habet).[76] No longer could any analogy be made between planar perspective and the concave surface of the retina.[77] By deciding in favor of dioptrics Kepler banished reflection as a model for human vision. The new visual devices had lenses—made by René Descartes, among others—that replaced mirrors as optical instruments.

Descartes taught that the visual impressions of both eyes were coordinated, and turned into a single image in the brain, the site of the *sens commun.* As a metaphor to express this he chose the blind person's cane. The eye functioned as a natural prosthesis of perception, just as a cane served as an artificial prosthesis for the blind. "One might almost say that they see with their hands," he wrote.[78] When a blind man touches objects with his cane, "It is certain that these objects do not transmit anything to him except that, by making his cane move in different ways according to their different inherent qualities, they . . . move the nerves of his hand, and then the places in his brain where these nerves originate."[79] The cane is similar to the ray of light that sends signals to the eye but does not copy anything visible in the process. The sensations that the blind man acquires with his cane when he feels his way are "nothing like the ideas he forms of them."[80] The authority of the subjective gaze had suffered a major setback.

"It is the mind which sees, not the eye" *(c'est l'âme qui voit, et non pas l'œil).* Such a bald statement represented a complete reversal with regard to the Renaissance faith in images and confidence in what the eye saw. Descartes continued: "This is why madmen and those who are asleep often see, or think that they see, various objects which, in spite of this, are not actually before their eyes."[81] He was in effect announcing the beginning of a new visual age. "It is necessary to beware of assuming that in order to sense, the mind needs to perceive certain images transmitted by the objects to the brain, as our philosophers commonly suppose," he concluded in the Fourth Discourse of his *Optics.*[82] Descartes's conclusions do not explain how similarity comes about between objects and our visual impressions of them. Pictures are good only for stimulating the mind to produce a representation of something, meaning a theory of signs has replaced the theory of copies so far as resemblances are concerned. Thus Descartes writes that engravings of cities or battles, being two-dimensional and based on a raster or grid, do not bear the slightest resemblance to the images that we see on them. The same holds true, he deduces, "about the images that are formed in our brain."[83]

By separating image and perception, Descartes returned to the foundations of the Arab theory, although he was not aware of this. His famous experiment with the eye of a cow consisted in removing the three membranes from the back of the

eye and placing the eye in "the hole of a specially made window" in a closed chamber similar to a camera obscura, "into which no other light is allowed to enter except that which will be able to penetrate through this eye." If the eye is facing forward toward some objects, and an observer inside the chamber then looks at the "white body"—that is, the retina of the cow's eye—he will see there "a picture [*peinture*] which will represent in natural perspective all the objects which will be outside of it."[84] "Now, having thus seen this *peinture* in the eye of a dead animal, and having considered its causes," Descartes reasoned, "you cannot doubt that an entirely similar one is formed in the eye of a live man."[85] The point is, however, that this is *not* our actual visual image, since we remain dependent on the opinion we already have about objects in our brain and do not rely solely on the eye. The resemblance of the "painting" in the eye to the world "is a very imperfect one," since the eye merely receives mechanical stimuli from outside.[86]

The eye was nothing other than a natural camera obscura. Descartes sums up this insight in the Fifth Discourse of the *Optics* when he observes that the images formed on the back of our eyes can be compared "with the images that appear in a chamber, when having it completely closed except for a single hole, and having put in front of this hole a glass in the form of a lens, we stretch behind, at a specific distance, a white cloth on which the light that comes from the objects outside forms these images." And for this reason people say that this *chambre* represents the eye.[87] Whereas in the chamber the images are upside down, we see them "correctly" in the brain. In his awareness (and his pictures) the human subject was withdrawing from the eye.

The dark chamber of which Descartes speaks was a closed room (similar to a movie theater) before it became a portable box. What was called the "perspective" in the chamber's opening was made up of lenses with which one could create images with the proper position orientation (in contrast to the lens of the eye). Leonardo da Vinci had already made early experiments with the camera obscura, but Giambattista della Porta (1538–1615) was the first to use a convex lens in the opening and thus correct the images in the chamber. He described it as "natural magic," the same term that the inventors of photography would later employ. As a piece of equipment, the camera obscura functioned more accurately than the eye and without the interference of subjective feelings, and at the same time it offered an excellent model for demonstrating how rays are bundled in the lens of the eye. This period of great advances, often known as the "scientific revolution," also saw the invention of the telescope and the microscope. These devices put to shame the relatively weak human visual apparatus.

The camera obscura soon found use outside of science, where it provided entertainment to a large public rather than proving any theories. Curiosity and a love of spectacle were characteristic of the baroque period, and the public enjoyed the deceptions the camera obscura could produce. What looked like machinations of the devil now became a question of technology. The Jesuit Athanasius Kircher's "catoptric theater," which he described in 1646, created exciting new effects and illusions through the use of a lantern, a mirror, and a revolving drum that made it possible to project a flow of pictures. This was the beginning of a second development, namely the magic lantern, in which the images did not come from the external world but were produced artificially. A projector replaced the light source for natural images. With this "magical or wonder-working lamp" *(lucerna magica seu thaumaturga),* Kircher wrote, one could amaze and terrify an audience by making the Devil himself appear on the wall. The logical outcome of this development was the "peep show." The public kept demanding new forms of entertaining illusions, although scientists used the same technology for their research.[88]

In these "chambers" there was no privileged eye point such as had been indispensable for linear perspective. Instead one watched the images come and go without producing them in oneself. Never before had pictures come into existence without the participation of a human subject, for even what mirrors reflected was a person's own gaze. When seeing was separated from the gaze and transferred to devices, it also became separated from the human subject. In the chambers people could also see pictures that moved and thus had greater appeal than static linear-perspective paintings, whose motion was only implied. From then on no one believed that a single image could be depended upon to depict a world that was constantly in motion, and painting came under pressure as a result. In Rembrandt's era Constantin Huygens wrote that in comparison with the moving images of magic lanterns, painting seemed "rather dead."[89] Artists then felt compelled to outdo the "chamber" in trompe l'oeil works with ever more realistic effects.

In December 1620 Sir Henry Wotton wrote a letter describing a recent encounter with Kepler, when the scientist showed him a nicely drawn landscape on paper in a camera obscura and said that he had made it "not as a painter but as a mathematician." Kepler owned "a little black tent . . . which he can suddenly set up where he will in a field . . . close and dark, save at one hole, about an inch and a half in the diameter, to which he applies a long perspective trunk, with a convex glass fitted to the said hole." The lens projected an image of the landscape outside,

and when Kepler placed a piece of paper on the image, he was able to trace a highly accurate copy of it. Wotton saw this as great progress, since "no painter can do them so precisely."[90] Now no one wanted to do without pictures created in the camera obscura, pictures that Alhazen had never mentioned and never desired, and they were already being mechanically produced, just as "photo-graphy," that is, light-drawing, would be later. The "perspective" of the lens had already taken over the tasks that would later be performed by the photographic device that succeeded the "chamber": the *camera.* The modern pictorial apparatus, used by laymen around the globe since the introduction of the Kodak method in 1888, had a direct predecessor in the "dark room," whose name was preserved as a laboratory for developing film. This apparatus carried on using the principle of perspective pictures with different technology. And looking back, we can see it proves that Western culture has always had the same obsession since it transformed the Arab theory of vision and its mathematics into an aid for making pictures.

4

Perception as Knowledge

A Theory of Vision Becomes a Theory of Pictures

Scholasticism and the Conflict over Perception and Epistemology

The insight that Alhazen's optical theory was just as aniconic as Islamic culture itself poses entirely new questions. How could Alhazen prevail in another culture in which pictures were indispensable? His work on optics was read during the Middle Ages at the Scholastic universities, where it belonged to the field of "natural philosophy" *(philosophia naturalis).* Yet conflicts could arise even in science when the notion of images came into play. This was the case when Alhazen was translated and his terminology was almost inevitably transformed in terms of pictures or was taken to refer to them. Such language then led to a misunderstanding with far-reaching consequences, namely that a theory of vision required grappling with the subject of pictures. At this point the Western development deviated from the original theory, in which pictures had played no role at all.

The issue of pictures, which was neglected for so long in the history of science, has given rise to confusion in recent studies on Alhazen, making a general reexamination necessary. To start with, this question caused problems of a particular kind in the culture of medieval Europe, where Alhazen was already known. At that time pictures were the province not of art but of theology, more images of faith than depictions of the empirical world. As such they were not directly affected by the new theory of perception because they addressed the "outer" rather than the "inner" senses; it was not thought necessary to express the process of seeing, an activity of the body, in pictures. Among scholars, however, Alhazen's optical theory led to a dispute over whether sensory perception could be the source of any genuine knowledge. This dispute also involved the relationship between the eyes and the mind, and it was by no means merely an abstract question, since it touched on the twofold quality of human nature, which was made up of body and soul. Since Alhazen's visual theory was more philosophically oriented and

supported by experiments, it was open to misunderstanding in a culture whose universities were dominated by Christian theology. The atmosphere of bad temper and irritability in which the debate over vision and epistemology took place reveals how much the theologians felt threatened by it.

The dispute centered on the "visual form"—called *species* in Latin—for Alhazen's optical theory made a distinction between the form of things as human beings see them and their true form. On one side of the debate stood Roger Bacon, who had adopted Alhazen's view, and on the other William of Ockham, who attacked its foundations.[1] Together with John Peckham and Witelo, Bacon led the group known as the "perspectivists," who had taken up the theory of Alhazen's *Perspectiva* and made it their cause. Bacon investigated the paths by which light rays and visual forms reach the senses and how they are communicated to the mind, that is, he wanted to know how reliable the senses are and what role they play in human knowledge about the world.

Roger Bacon (1214–1292), an Englishman known to posterity as *doctor mirabilis,* became a Franciscan friar in 1257 but soon became embroiled in conflict with the order because of his teachings. In 1267 he wrote his *Opus majus,* a seven-part treatise commissioned by the pope that covered a number of topics, including optics. Bacon based that section on Alhazen, whom he had read in a Latin translation. During this same period Witelo, who had been born in Silesia around 1230, studied optics in Padua. He wrote a textbook on the subject in the 1270s, borrowing the Latin title *Perspectiva* from Alhazen's work, and also taught Alhazen's theories at the University of Padua. John Peckham (1225–1292), an encyclopedic scholar and archbishop of Canterbury, advanced Alhazen's views in a general treatise on optics entitled *Perspectiva communis.* William of Ockham (1285–1347), another Franciscan, belonged to a younger generation and became a spokesman in his lectures at Oxford for the opposing faction known as "nominalists." For Ockham, objects in the world could not be reduced to general categories and the human mind could grasp them only by intuition. For this reason he refused to tie knowledge to a perception that was wholly bound to the senses.

It was easier to reconcile Western theology with light as a cosmic force than with light as Alhazen had presented it in his work on sensory perception, since Christian theologians saw light as God at work in the world. They viewed the new theory as simply a confirmation of the old metaphysics of light, although naturally they ignored the fact that Alhazen spoke of light in decidedly physical terms. Roger Bacon tried to apply his knowledge of optics to theological questions, observing in his main work that God's grace reaches human souls in much

the same way that a straight, unbroken ray of light strikes the crystalline of the eye.[2] By characterizing light as a reflection of the "invisible reality" of God's creation (Epistle to the Romans 1:20), Bacon endowed optical theory with a metaphorical character that pointed beyond the physical world.

The definition of pictures was also so strongly based on theology that its link to optical knowledge encountered resistance. The world could always be "narrated" in pictures, since it was a world of revelation and history, yet narration did not mean that artists depicted the everyday world as people saw it. Optical knowledge invaded the domain of theology when, through the eyes with which human beings acquire their own impressions of the world, it awakened a desire for another kind of picture: pictures that did not just explain what the world meant but represented it in the way people perceived it with their own eyes. In the transformation of perception into epistemological knowledge an anthropological turning point occurred. This became evident in artistic practice even before the Renaissance invented linear perspective.

How did scientists treat pictures in their discussions of optics at that time? It emerges that they relied on different concepts, in fact. Optical theory was not interested in the resemblance of the world to a picture or painting as artifact; rather it had to do with the resemblance between the *object* that we perceive and the *form* in which we perceive it. The question for the visual process ran: What is an object as such and how do we perceive it? For this kind of resemblance, optical science used the Latin term *species*. Like Alhazen, Bacon understood it as the "form" that objects impress on the eye.[3] It is always the form of an individual object and not the visual field in general. According to Bacon every visible object produces a particular form *(species)* that is transmitted to the eye through the transparent media of air and water. In contrast to Alhazen, however, Bacon equates the form with image and resemblance. This species or form multiplies "along rays proceeding . . . from all points on the object's surface . . . Once received in the sense organ, each species continues to be multiplied along the optic nerves into the cavities of the brain housing the internal senses."[4] There is found the "ultimate sentient," that is, the organ to which perception is ultimately transmitted.

Bacon refers to the effect that objects produce in us as their "intention." Avicenna had distinguished between form and intention, but this question need not concern us here. Like Alhazen, Bacon regards light and color as the only qualities accessible to the senses, whereas the composition, size, and distance of objects can be perceived only with the aid of the faculty of judgment. It alone can deduce the nature of objects from characteristics dependent on factors such as time and other

conditions.[5] Here lies a key problem of perception. Bacon assumed that objects leave behind a visual impression in the senses. "This impression is Bacon's *species.*"[6] Thus the *species* could not be only form for him but had to transmit likeness. This understanding distanced him from Alhazen's concept. In Bacon's thought the eye reacts to the *species* as an observer reacts to a picture. Significantly the title of Bacon's chief work in English translation says that the visual form "propagates likeness."[7] From then on *species* could be understood as a picture, and the act of seeing turned into a process of representation.[8]

Bacon's theory of perception was rejected by his fellow Franciscan William of Ockham when the latter took up his teaching post at Oxford shortly before 1320. Ockham attacked a visual theory that he considered—to put it in modern terms—merely a media theory, since it distinguished the true gestalt of objects from their changeable appearances, their *species in medio,* which were affected by conditions such as available light and a person's eyesight. To free epistemology from accidental conditions of vision, Ockham declared it to be exclusively the province of logic. Whereas Bacon linked epistemology to the sense of sight, Ockham reserved certainty about objects in the world to the act of cognition.[9] The debate was intensified by the church's concern that it might lose control over the definition of human nature as twofold (body and soul), but this was a battle the church had already lost. Empirical knowledge had long since ceased to be merely a topic among scholars, for it promised liberation from the leash of the church in mastery of the world. What Ockham referred to as "abstractive cognition" was the domain of the intellect, and it also guided intuitive knowledge. If we know objects primarily through intuition, then we cannot see anything independently of objects, that is, any visual forms of them. "There is," Ockham conceded, "intuitive cognition in every sense . . . by virtue of which . . . a thing is known to be or not to be" *(rem esse vel no esse).* One should not believe, however, "that there is no intuitive cognition unless it is ocular" for "that is false" *(quod falsum est).*[10]

In his invective against overemphasizing the sense of sight Ockham also attacked pictures, which were increasingly associated with visual perception rather than with narration. Such images carried with them the danger of error, for they could deceptively simulate knowledge that he considered to be solely a matter of the intellect: "What is represented must be known to us before; otherwise the representative will never lead to the cognition of what it represents," no matter how great the similarity.[11] Alhazen would have been amazed at this dispute, since images were foreign to his thinking. Only in Western commentaries on his work did representation become a problem of the *species,* which shows objects under

changing conditions. Ockham thus sided with Aristotle and accused the "perspectivists" of being overly concerned with vision; their relativism could end only in deceptions.

This kind of polemic proves how much the epoch was struggling with the sense of sight and its role in epistemology. Bacon ranked it first among the senses, arguing, as David Summers puts it, that "we especially delight in our sense of sight, the objects of which, light and color, are the most beautiful things apprehended by sense, from which, in addition to beauty, utility and necessity also arise," a reference to the mechanical arts. Bacon is alluding to Aristotle when he writes that "only sight shows us the differences of things; by means of it we search out certain knowledge of everything that is in heaven and earth." He also mentions new devices—such as reading glasses, which were invented during his lifetime—observing that they function like the eyes and thereby prove that genuine experience is always gained through the sense of sight.[12]

The significance of visual perception was no longer solely a scientific question, as public authorities felt their control over doctrines and articles of faith was threatened.[13] Epistemology was now tied to a sensory organ that was easier to deceive and more difficult to train than the intellect. Studying the world by observing it oneself was appealingly adventuresome, and the appeal was only increased by the resistance of the church. The battle between empiricism and the theological explanation of the world had not yet been won, however, since for theologians the gaze was also a major topic. But they were concerned with a different kind of gaze, and during Ockham's lifetime the public discussion centered on an entirely different kind of vision.

The subject of this debate was the "vision" of God that would be granted to the blessed in the afterlife. Earthly vision paled in comparison, and mortal life appeared as merely a prologue to eternal life. The church did not mean the ordinary human sense of vision when it promised an absolute vision of God in eternal life. The conflict escalated when the pope in Avignon declared in 1331 that those who died in the faith would behold God in heaven only after the Last Judgment and not after their own death.[14] He was forced to retract this thesis when it produced general outrage that the faithful would be deprived of valuable time when they hoped to enjoy the beatific vision. In his visions of the afterlife in the final verses of the *Divine Comedy,* Dante presents the actual vision of God as an indescribable experience, and yet he used poetic license in claiming that he had seen the other world with his own eyes. And by doing so he undermined the borderline between physical and metaphysical vision. About a century after his death, Dante's view of

heaven and hell was painted in a chapel of the Dominican church in Florence, the Strozzi Chapel of Santa Maria Novella, almost as if he were being cited as an eyewitness. In the frescoes the poet is portrayed as keeping his gaze fixed on heaven so he can relate what he saw there.[15]

In the dispute over the sense of sight, empiricism entered the province of science, and it would not be long before it also reached that of art, which until then had been at the service of religion. The point could be foreseen when the process of seeing would also become the standard for making paintings. The gaze was demanding pictures of the world and wanted to procure them. In Bacon's time there were no "analog images," as we call them today, meaning images that depict the world the way we ourselves see it, but the path leading to them had opened up. We can scarcely imagine how controversial the subject was then, since in the meantime the evidence provided by pictures has become an obsession.

The will to turn the empirical world into an object of visual knowledge led to a paradigm shift, in Thomas S. Kuhn's well-known phrase. The linking of optical laws to the individual gaze and its competency created a new line of demarcation between Western and Arab culture. The sense of sight became a privilege of the human subject, who demanded the privilege of seeing the world with his or her own eyes. And this in turn made it unthinkable that painters would cling to an outdated studio tradition and pass up the chance to acquire a monopoly on visual practice.

Artists seized the opportunity, and in the process employed a kind of new rhetoric by making a narrative or idea clear through the use of empirical examples based on experience. European literature was shifting to vernacular languages in order to make the topics of the day accessible to a broader audience. Writers wanted to make the public media "popular," as we would say today, so as to gain more followers. A contemporary of Dante, the writer and poet Francesco da Barberino, distinguished between rhetorical *exposition* and sensorial *inspection* of the real world so as to win over even a nonliterary audience—like a painter.[16] To create such sensory materials, illustrations would first have to become naturalistic, and it was scarcely possible to have two types of pictures at the same time, one that resembled nature and another that did not. "Resemblance" reflected the decision on principle to include the act of seeing and the *species* in the syntax of paintings. At the town hall of Siena, Ambrogio Lorenzetti's painting known as *The Effects of Good Government* made use of a novel kind of painted cityscape showing a flourishing city and the fruitful countryside around it. In this case per-

ception was a function of exemplary realism and not a topic in and of itself; that would come only with the advent of linear perspective in the Renaissance.

Before Perspective: The Gaze in Giotto's Painting

Italian art in the century before perspective is inseparably linked with the name of Giotto di Bondone of Florence (died 1337). Contemporaries considered him the founder of the "good new style," the manner of painting that laid the groundwork for the Renaissance. Yet the issue of whether Giotto "invented" linear perspective or merely "anticipated" it has divided scholars repeatedly and sometimes led to questionable compromises.[17] The fact is that mathematical linear perspective was not invented until a hundred years later. If Giotto did not invent it, however, what is it about his art that immediately strikes observers as new? The answer that comes to mind is this: Giotto transformed art by introducing the changeable form *(species)* of objects. In his day the perspectivists had caused a furor at the universities with their thesis that human beings perceive objects not as they really are but only as they appear; this meant that in questions of perception there could be no certainty.

Painters responded by beginning to simulate the presence of an observer in their pictures, meaning that they imitated the process of seeing. Yet if they wanted to relate their paintings to an external viewer, and to create the impression on this viewer that he was seeing a painting the same way that he saw the real world, they still had to rely on technical experiments. In the syntax of his own works, Giotto conjured up on the painted surfaces bodies and objects that were positioned in a *spatial situation,* even though the mathematical method for *systematically* representing three dimensions on a flat surface was not invented until two generations later (see p. 146). Not until then did artists achieve the goal of orienting every painting toward the gaze of an observer standing in front of it, in the same way each time and according to fixed rules.

The notion of calling certain paintings "pre-perspective" touches on a distinction that art historians have made between two different kinds of perspective. First of all, there is "mathematical perspective," which is also referred to as "central," "linear," or "artificial perspective." It was invented by Filippo Brunelleschi in

Florence and first described by Leon Battista Alberti (see Chapter 5). In addition, the phrase "natural perspective" has been used by scholars to describe a manner that painters developed intuitively, through a process of trial and error. But is the term "perspective" at all appropriate here? What matters in the end is that perspective is a system and not just an intention. We have also seen that the term already had a history in the scientific theory of optics. It seems best to replace "natural perspective" with the concept of the "visual form" and the gaze, that is, with a formulation in use at the time (even though it was the subject of controversy). As is well known, the visual theory of Arabic origin was not equivalent to the pictorial theory of the Renaissance. The idea of pre-perspective painting would apply to a kind of art that was already experimenting with drawing the gaze of a beholder into the picture, not long before the invention of perspective itself.

The desire to make Giotto the inventor of perspective crops up among Florentine writers, who celebrated him as the founder of the city's artistic tradition. In 1489 the Medici family commissioned a monument to Giotto for the Florence Cathedral (see Fig. 58), with an inscription composed by the celebrated poet Angelo Ambrogini, known as Poliziano. The author lets Giotto speak in the first person, claiming to have brought back to life the extinct art of painting, but he does not mention perspective.[18] Giotto's contemporaries referred to what they recognized in his art as *naturale,* a term for an impression of nature. In nature optical conditions also prevailed, such as distance, brightness, and angles of vision, all of which were considered dependent on the eye, and so painting that simulated the angle of vision of a beholder produced a natural effect. In the technical language used by Alhazen, "forms"—the visual impressions created by objects—differed from the objects as such.

Giotto's series of experiments in depicting physical space reveal his awareness that "forms" are varied, contradictory, and shifting. They were always referred to in the plural because they implied distance as well as size, angle of vision, and illumination. The term "forms" consigned objects to the changing conditions of perception. The invisible "rays" that such forms used could be included in a painting symbolically by depicting floor tiles or—most easily—ceiling beams. In this way painters simulated the paths that light travels between physical objects and the eye, thereby rendering visible the distances and angles of vision that had played a central role in the earlier Arab theory of optics. Yet it was difficult to coordinate the people in the painting with these pathways, and it was not yet possible to calculate a fixed vanishing point for the orthogonal lines.[19] This "not yet" is

not owing to a lack of perspective, however; it simply represents the state of affairs before a mathematical technique for constructing a picture was invented.

A chronicler of Florence confirms that contemporary observers suddenly saw themselves in Giotto's art. Filippo Villani praises Giotto for approaching nature so closely *(naturae conveniunt)* that "to those who behold them [*intuentibus*] his paintings seem to live and breathe."[20] In his description Villani makes a play on the words *fingere* (to invent) and *pingere* (to paint) that is possible only in Latin. Just as in literature, fiction had now entered painting. It consisted precisely in imitating the kind of perception that existed only in the world of nature. Beholders were courted here similarly to the way writers courted their readers. Just as Italian authors were ceasing to demand familiarity with Latin and concentrating on the vernacular language, painters were dispensing with a didactic attitude and suggesting an everyday manner of perception.

Wolfgang Kemp speaks of a "narrative space" in which "space and action are coordinated" when painters provide a "set" or scene for a narrative.[21] If they give this setting an identity by always depicting it in the same way, then viewers will also recognize it in a different narrative situation. I would like to add that this procedure was also popular at the time in methodically training the "art of memory" *(ars memoriae).* One handbook of this sort, which was ascribed to Cicero, enjoyed such prestige in Siena that Ambrogio Lorenzetti illustrated a title page for a costly manuscript copy of it some time around 1336. The handbook mentions the need to relate "places" and "images" with one another in one's memory, so that particular sites are always associated with a mental image: "Nature teaches us how to proceed. Where we have seen things in life, there they will also remain in our memory." Artificial memory, which must be practiced, just like artificial perspective later, keeps "images of things we want to remember in the places where we saw them."[22]

Pre-perspective painting cannot be summed up with the phrase "narrative space," however. In the Arena Chapel in Padua (which dates from before 1310) Giotto boldly introduced the gestalt of painted interior rooms without a story attached to them, as if with a trumpet fanfare. There *space* is unexpectedly transformed into the visual *form* of a space. It is a purely optical experience or, if you will, an optical illusion. On both sides of the choir, the walls appear to contain openings into chapels, but they exist only as painted fictions (Fig. 46). The walls and vaulted ceilings of these imaginary chapels are foreshortened in such a way that observers have no choice but to relate them to their own gaze.[23] The theme

here is "visual form," in a double sense. In their *fictional existence* the chapels have no counterpart in reality; in addition they are linked to observers who have a view into them only from one side, because they are standing between them rather than directly in front of them. It is not yet possible to calculate an eye point, as it is in Masaccio's work a hundred years later (see p. 179)—quite the contrary. If viewers raise their gaze on one side of the choir they will see (painted) bays depicted from a different angle of vision, since they appear to project out from the painted surface. In these fictitious chapels Giotto did not have to tell a story and could therefore concentrate entirely on the gaze per se. Since the chapels had no real existence, in one swift stroke the painter separated the visual "form" from the physical reality that it portrays. His strategy succeeded doubly, in that the proximity of the painted rooms on each side transforms the *real* choir of the chapel—before which visitors are standing—into pure form as well.

Painters before the era of perspective were free to experiment as they liked and did not yet have a mathematical definition of space imposed on them. Even though only fragments of Giotto's work survive, we can still get an idea of the path he followed in his experiments. The chapels of the Bardi and Peruzzi families that he painted in Santa Croce in Florence provide one clue. Visitors then had only a limited view into these spaces, which were high and narrow, because as private chapels, access to them was limited. For this reason, as John White observes, "The internal architecture perspective is co-ordinated with the viewpoint of the observer as he enters" (Fig. 47). In the individual scenes, "The visual axis lies not in the geometric centre of the composition, but slightly towards the entrance of the chapel. The perspective . . . goes halfway to meet the spectator."[24] White is speaking of both chapels, but in fact the Bardi Chapel, which is decorated with scenes from the life of St. Francis, lacks this effect. There the architecture is still strictly centered, with one exception. Only in the adjoining Peruzzi Chapel are things as White describes; there the angle of vision for all the buildings is oriented toward the entrance. What this actually means is that the true addressee of this painting is an external viewer. The scenes from the life of St. John in the Peruzzi Chapel do in fact go halfway to meet the spectator, as if observers standing at this spot were crossing not just the threshold into the chapel but also the threshold into each picture, and becoming eyewitnesses of the events shown.

Figure 46: View of the choir of the Arena Chapel, Padua, with Giotto's trompe l'oeil frescoes (Mondadori Electa).

Figure 47: View of the choir chapels of Santa Croce, Florence, with frescoes by Giotto, 1320–1330 (Mondadori Electa).

We have no information on the dates of the painting in the two chapels, yet the sequence cannot be in any doubt. The direction that Giotto's experiments with visual forms were taking is confirmed only a few steps further on, in the chapel of

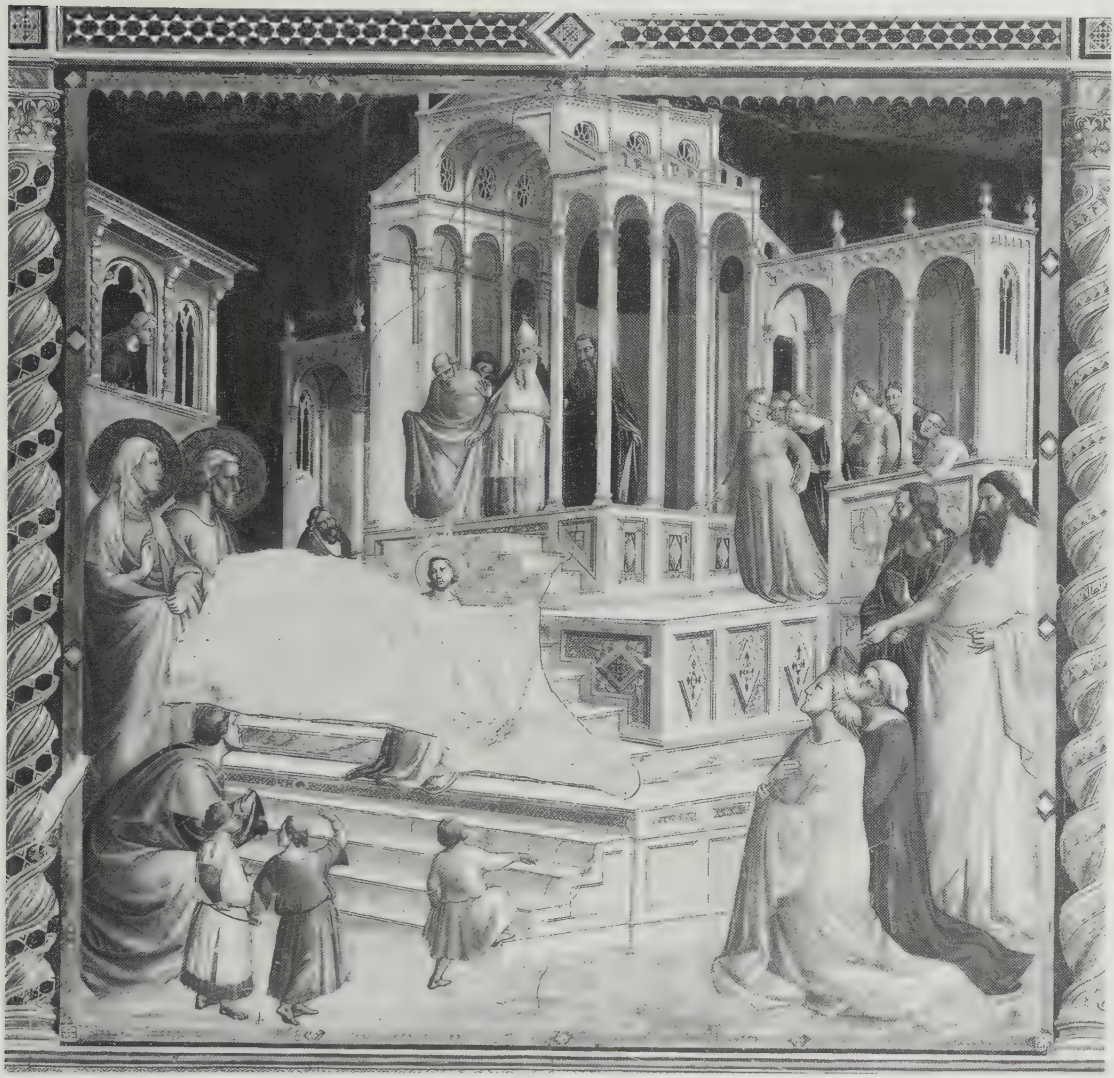


Figure 48: Taddeo Gaddi, Presentation of Mary in the Temple, Baroncelli Chapel, Santa Croce, Florence, 1332–1338 (Scala / Art Resource, New York).

the Baroncelli family. There his master pupil Taddeo Gaddi carried on the development with aplomb. This chapel, built about 1330, presents a summation of Giotto's series of experiments, so to speak, for the scenes from the life of the Virgin are definitely intended to be viewed from one side.[25] The architectural elements are placed at such an angle to the picture plane that they seem "right" only when they are seen from the threshold of the chapel, and the same holds true for some of the figures. Prime examples of this are the two depictions of the Temple in Jerusalem, one of which would soon become famous in French manuscript il-

Figure 49: Taddeo Gaddi, Still Life with a Wall Niche, Baroncelli Chapel, Santa Croce, Florence, 1332 (Mondadori Electa).

lumination (Fig. 48). The boldness of the experiment with the visual form is exceeded only by the still lifes at the level of the pedestals, the very first of their kind (Fig. 49). These consist of painted trompe l'oeil niches that appear to contain various implements and books. Their effect is heightened by the way they alternate with sections of "plain wall," though of course the impression of "open" and "closed" spaces is a fiction. Once again we can speak of a painted visual form. The niches appear realistic only when one is not standing directly in front of them.

In the refectory at Santa Croce, Taddeo Gaddi undertook an even bolder experiment in *The Tree of Life* on the front wall, part of which depicts the Last Supper (Fig. 50). This Last Supper has remained unique in art history in the way that the table and the apostles seem to be floating in space before the wall rather than on the wall.[26] In a manner of speaking the life-size painted figures "pulled" the observers (who were also eating a meal) into the picture with them, merging the painted room with the real one and uniting the two different groups of diners. No single-perspective location existed for viewers; they were visitors in an imaginary space in which the boundary between painted picture and imagination remained open. This merging of imaginary and real space is precisely what distinguishes this work from a perspective painting, which requires that the observer be at a fixed distance to experience the desired effect. Here the visual form has become a fictional reality in which seeing and being can no longer be separated.

During these same years painters in Siena were undertaking yet another sort of experiment. There, followers of Giotto attached more importance to painted architecture than to human figures as a way of establishing a sense of three-dimensional space. A form of architectural realism in the tradition of Duccio had become the fashion in Siena. This may explain why the painter Pietro Lorenzetti —to an even greater degree than his brother Ambrogio—achieved a real tour de

Figure 50: Fresco in the refectory of the monastery of Santa Croce, Florence: The Last Supper, detail from Taddeo Gaddi's Tree of Life, 1360 (Alinari Achives, Florence).

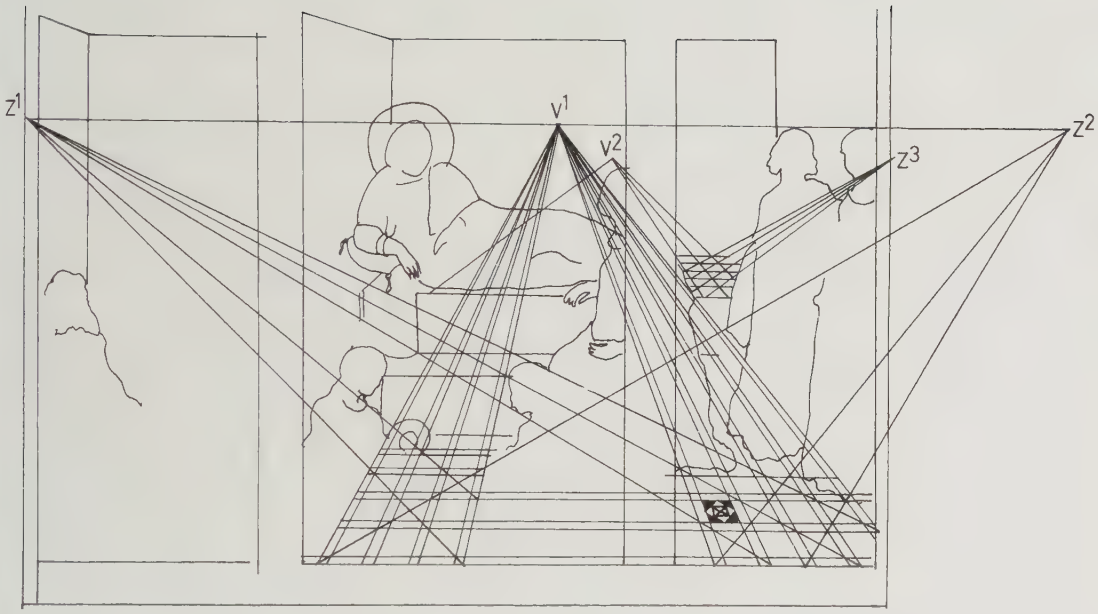
force in 1342 with what I have called "visual form," in his altarpiece for the Siena Cathedral. It is a triptych depicting the birth of the Virgin (which has come down to us without its original frame; Fig. 51).[27] The extraordinary nature of Lorenzetti's achievement begins with the outline of the lost picture frames, which now look like window frames. They turn the three sections of the painting into the interiors of two rooms, which we recognize as the birth chamber and an anteroom.

Yet the artist was still struggling with one problem: how to organize the two rooms so that the eye takes them in at the same time. He concentrates on the main room, where with the aid of Martin Kemp's diagram (Fig. 52) we can see that the floor tiles recede to a different vanishing point (V^1) than the squares on the bedcover (V^2). In addition he uses one diagonal focus (Z^1) for the distances in the room and a second focus (Z^3) for the bedcover. The underdrawing is incised in the gesso or primer coat. The artist's effort to engage the viewer is evident in his choice of different angles of vision for the floor and the bedcover, as well as in the asymmetrical views of the ceiling vaults. However, notes Kemp, "Effective though this system is [i.e., the use of two vanishing points], it was not supported by any theoretical proof—geometrical or optical—and it remained only one of various means of organizing space during the *trecento*."[28] We should not content ourselves with analyzing the workshop practice alone, however, for not everything here is purely empirical. It is true that we are still at a stage before the invention of math-

Figure 51: Pietro Lorenzetti, The Birth of Mary, altarpiece from the Cathedral of Siena, 1342, now in the Museo dell'Opera del Duomo, Siena (Scala / Art Resource, New York).

ematical perspective, but the goal of such experiments was already to make the gaze of a viewer present in the structure of the painting.

Visual forms did not provide a *formula* that artists could use in their daily practice. Yet they appear to have been the guiding idea behind artists' attempts to simulate a three-dimensional space in which objects were presented in varying sizes and at varying distances, regardless of whether painters used what is called the convergence system or let lines recede in parallel. No matter how lines were shown receding into the depth of a picture, they rendered the visual rays visible, as it were. Artists could not depict them as such, since they were invisible and of a geometrical rather than a physical nature, so they had to represent them symbolically by using the edges of buildings or rows of tiles.



Visual rays, represented symbolically as receding lines of sight along architectural structures, became a way to lead a viewer's gaze. Scientists argued over the reliability of the "forms" transmitted by visual rays; their debate revolved around how to link *epistemological* and *practical* knowledge of objects as they really were and not merely how they appeared. Painting pictures became the acid test. The attempt to incorporate the variability of visual perception into painting opened up a fissure between the act of seeing and the seen world, a gap that people were increasingly impatient to close. The issue of pictures in particular demanded a logical solution, in order to progress from fleeting impressions to a secure knowledge of things. At this juncture, mathematicians' idea to measure space as such had to be a welcome innovation.

Figure 52: Diagram of Pietro Lorenzetti's Birth of Mary, from Martin Kemp, The Science of Art (courtesy of Martin Kemp, after The Science of Art: Optical Themes in Western Art, Yale University Press, 1990).

Pelacani's Invention of Mathematical Space

At this point it becomes necessary to introduce the name of a philosopher who is little known in the scholarly literature on perspective. Biagio Pelacani of Parma (died 1416) is nevertheless a key figure if one wants to understand the invention of linear perspective. Pelacani knew Alhazen's work extremely well and altered some of the earlier scholar's premises in order to stabilize physical bodies in space and thereby make them knowable. Pelacani's work on perspective remains rarely mentioned, but from it it emerges that he disagreed with the rest of the theory of perception, then referred to as "perspective." It signified for him a theory of vision, but he redefined key elements of it.[29] In the controversy over visual experience and epistemology that was then being waged at universities, Pelacani believed that the solution lay in mathematics: "Mathematics provides the highest degree of certainty and is superior to all other disciplines in its powers of insight and the beauty of its proofs." He also declared that "a single proof in geometry conveys more knowledge than is offered by all natural philosophy."[30] These verbal barbs were aimed at the "perspectivists" like Bacon and Witelo, who in Pelacani's eyes tended to relativize perception too hastily. It was an error, he was convinced, to believe that some objects appear larger than others only because they are seen with a greater angle of vision.[31] He himself held the distance and size of objects to be real, because they are measurable quantities.

Biagio combined a "concrete" mathematics of the physical world with a theory of empty space, which could be defined only by its extent *(latitudo)* and the location of physical objects in it *(distantia)*. By introducing empty space into post-Islamic visual theory Biagio laid the foundations for the pictorial theory of linear perspective, which was invented in Florence during the last years of his life. He established the epistemological basis for the sensory act of seeing that was a subject of such debate among contemporary philosophers. Yet his name plays no role in studies on perspective, and even in the history of science his invention of mathematical space receives little mention. In Biagio's theory of vision, space was a quantitative dimension that provided reliable data from the external world. Through the measurement of objects and their distance from other objects, size *(quantum)* and proportion became the cornerstones of visual perception.

One reason why Biagio deserves our attention is that he received it from Brunelleschi and his circle. Although his name is not mentioned in surviving con-

temporary texts on the subject of perspective, there is documentation of his presence in Florence on the eve of that revolutionary development. Biagio first taught at the Studium, as the university in Florence was then called, in 1388, and the following year the friends of the "garden" of the Alberti, a group of scholars, celebrated him as a "universal philosopher and as the outstanding mathematician of his time."[32] In 1397 copies of several of his books were requested by readers in Florence. In the following years Pelacani lectured in Padua and Pavia; then in 1412 he retired to Parma, where he died in 1416. There is still a manuscript in the Biblioteca Laurenziana of his work "Questions of Perspective," containing a note by a Florentine scribe that he had finished copying it in March 1428.[33]

Biagio's conclusions were supported by Vitruvius's theory on architecture, which was rediscovered at about this time. Vitruvius wrote about proportion in clear and concrete terms that were very welcome in the discussion of vision, where proportion was also a key notion. His rules on proportion had been a system for determining the dimensions of buildings, so architects of the Renaissance set about trying to confirm them by measuring what remained of classical structures in Rome with a procedure that made use of linear perspective (see p. 172). Piero della Francesca translated painting, in turn, into clearly mathematical terms in order to lead the viewer's gaze by means of accurate dimensions (see p. 154). The transformation of the post-Islamic *theory of vision* into the *theory of pictures* founded in Florentine central perspective could not have occurred without a new definition of three-dimensional space as visual space. Only in this kind of space, which symbolized the visual field of the eye, was it possible to determine the location of visual rays and visual forms.

Biagio ended the dispute over perception and epistemological certainty when he traced knowledge back to the visual process: "Vision alone is not sufficient to determine the size of one object or another," but the size can be determined by investigating an object's "proportional relationship to an object whose size is known. That cannot be done without a comparison and without a definition. From this it follows that seeing and knowing are the same thing, for in the power of sight there lies a cognitive power."[34] We can recognize Alhazen's arguments here (see p. 106), but Pelacani draws different conclusions from them. Geometry was suited not only for determining the pathways along which light travels; it also opened up a new topology of the physical space that objects occupy. This important shift of emphasis can be illustrated with the following example: Alhazen noted that when we look at the sky we perceive it differently directly overhead than at the horizon, and he attributed the difference to the angle of vision and the

atmosphere. Pelacani explains the different perceptions by observing that our sight encounters no obstructions when we look straight up, but "between the horizon and the eye many various bodies are interspersed," which either help or hinder us in judging distances.[35] Biagio reduces all physical bodies to a particular gestalt unique to each that is mathematically quantifiable—that is, all its dimensions can be measured or calculated. The (visual) *form* of objects is then physical insofar as it is always linked to an underlying body *(subjectum)*. Its material gestalt occupies a certain extent *(latitudo)* in space. Here Biagio departs from the dominant theory of vision at the time, which was formulated in terms of points on surfaces that connect light and the eye. He also abandons the hierarchy of transparent and opaque bodies that either obstruct light or allow it to pass through unhindered. He places the emphasis on objects themselves, since it is the knowledge of them that concerns him: "Everything that we see we see as a whole and as a fixed shape [*sub angulo solido*]."[36] "Every form extends to the same degree as the object to which it is inseparably attached."[37] Reality "can always be described in terms of numbers and proportions. When we want to determine the size of something, then we demand that it be measured precisely."[38] In these statements the author is revising optical theory in order to give it more certainty. The world of physical objects is measurable for him, and thus it exists as we perceive it.

A further aspect to the topic requires mention here. In his definition of space Biagio Pelacani abandons Aristotle's axiom that "nature abhors a vacuum" and introduces the idea of empty space, of space as such—that is, a vacuum. In so doing he makes space the correlative of the physical bodies that fill it and also organize it. Empty space can be illustrated, for example, with the interval between the neck and bottom of an empty vase. In principle a vacuum is either "a space that is not filled with a body," or emptiness per se, which now acquires its own quality.[39] Biagio's examples are always simple and vivid, as when he says that a stone thrown in empty space will have a different trajectory than one that encounters obstacles.[40] The significance of empty space is that it is introduced for the first time as an element of visual theory; it is measured along with physical objects and at the same time related to a human subject, an observer who recognizes it by the things that exist within it. The *epistemological knowledge* with which Pelacani is concerned is of an *objective* kind, but it is intended for a *subject* who wants to acquire it from things. The concept of a body and the concept of space, both of which are positioned in geometry, become complementary in the theory of the visible that would soon take pictorial form in Florence. The geometry of the perspective painting assures the spectator that everything actually is as he or she sees it.

Biagio concedes that deceptive images can creep in between the visible world and the eye, but he wants to correct them through measurement and knowledge. One must not fall victim, he says, to the "error" of substituting the "visual form" *(species)* of the "perspectivists" for the object that is seen.[41] This is now the essential point. Biagio bases his view on the fact that the (visual) form is always first caused by an object that carries or emits it, and the form possesses the physical characteristics of that object. He uses terms for perception such as figure *(figura),* visual form *(species),* and deceptive image *(idolum).* He seems to prefer "figure," since the word can also describe an object seen as a whole, but at the same time it still has a geometrical meaning that now becomes concrete and tangible.

Here Biagio is paving the way for a pictorial concept that was lacking in Islamic optics. In the term "figure" he understands both a physical body and its dimensions or extension in space. "The figure and size of the sky have existed since the beginning of time just like the extension of nature as *materia prima.*"[42] Yet he also understands visual forms as qualities that have a material basis and do not exist solely in rays of light. For his purposes, he says, it does not matter whether "the visual form travels from the eye to the object or vice versa," as the "philosophers," the natural scientists of that day, were accustomed to debating.[43] Biagio always remains focused on the real physical world. He ascribes to the eye (in combination with the mind) the ability to acquire genuine knowledge, but first the physical world must offer the conditions for us to obtain reliable information about it.

His theory definitely still leaves room for visual rays, which are not visible themselves but make the world visible. "If there were no visual rays," then it would not be possible to see someone standing behind me "by taking a mirror and holding it before my eyes. The rays that this person sends out strike my mirror and are redirected from it to my eyes," that is, reflected. In this way someone can see a person in front of him even though he knows the person is actually standing behind him.[44] Mirrors are both the medium of visual rays and the proof of their existence.

All the same, Pelacani continues, one must not let reflections in the mirror mislead one into thinking that they are entirely illusionary, so that the physical existence of the bodies being reflected is denied. "I must ask myself whether, when I look at myself in a mirror, only a phantom [*ydolum*] of myself appears before my eyes, or whether I can see in it what or who I myself am [*quod ego sum*]." For if I could not see myself in the mirror, "then one visual form would just double itself in another and so on. Whoever is caught at this point will see only such [illusions] multiplied in the mirror. Therefore what appears in a mirror is not just a

phantom [*ydolum*] or a mere form [*species*], which is the same thing. What we see in a mirror is the object toward which the mirror is directed, since the form is determined not only by the act of seeing but also always by the object" that generates it."[45] Even in front of a mirror Biagio does not want to lose sight of reality. The mirror's surface shows an image to an observer, but it is his own image and a witness of his own presence. Since we are not simply images but also have a body, we are led by the reflection in the mirror to look at ourselves.

We encounter in the person of Biagio Pelacani a thinker who, on the eve of the invention of central perspective, took the visual theory of Arab origin with its geometry of light and rays and added a revolutionary new element. He invented a mathematical space in which physical objects became just as measurable as the space they occupied. In so doing he expanded the laws of optics, which had been affected by the suspicion that the eye can be deceived, to include the fact that the dimensions of objects can be measured. He declared this to be a true understanding of the world. Pelacani thereby opened up a topology of visual space in which objects have a firm and solid existence and can be represented by art. He was one of the foremost experts on Alhazen, but he interpreted Alhazen's theory differently than the "perspectivists" of Scholasticism, rejecting and contradicting their conclusions as a logician and mathematician. In Florence, the model of central perspective translated Biagio Pelacani's idea of a topological visual space into tangible works of art.

Ghiberti's *Commentaries* and Piero's Mathematical Art

The Renaissance gave its own particular stamp to the idea of "art" and laid the essential foundation for the next development, when painting pictures came to be regarded as an applied science and were freed from the routine of an artisanal workshop. The Latin term for the arts, *artes,* was ambiguous, since traditionally it connoted practical skill. Now notions of "theory" and "method" were being added to it, a change made easier by the fact that the word had long been used in academic circles. In the case of perspective, painters asserted that they were adopting a new method from the science of optics and applying it to making pictures. Strictly speaking one could reproduce the geometry of visual rays only in diagrams, but painters began to use these diagrams as an underlay for paintings that

they understood as facsimiles of the images seen by the human eye; *visio*—vision—was coming to mean not only the *act of seeing* but also *what was seen.* Their project was to replace objects as they were seen with *painted* objects, and to replace the mental image seen by a person (invisible in the outside world) with a visible canvas. The rationalization of the practice of making pictures transformed painting into what we today would call an imaging process.

The Florentine sculptor Lorenzo Ghiberti (died 1455) was one of the first artists who could speak of perspective in a double sense. He attempted something out of the ordinary by introducing contemporary knowledge of optics into the literature on art, a genre that he himself founded with his work titled *Commentaries.* It was at this time that the term "perspective" acquired a twofold meaning: it continued to denote the scientific theory of vision but now also became the term applied to the new theory of making pictures. Optics was of course concerned with a different subject than art, and mathematicians and the arts occupied different camps and spoke different languages. Yet Ghiberti, along with his fellow artists, was filled with ambition to create a new paradigm for optical science.

This project was so important to Ghiberti that his *Commentaries* acquired a character otherwise known only in works by scientists. In the first volume he dealt with ancient art, using Pliny and Vitruvius as sources, while in the second he traced developments up to contemporary artists and his own work. The author waited until the third and final volume, which he wrote in his old age, to cover the subject of optics in the vernacular language, for artists. He admitted both the contradictions and the errors made by copyists in the texts he had used as sources, since in this work Ghiberti was mainly a compiler and copyist himself. He spent so little time reworking his own texts that they remained virtually unusable until Klaus Bergdolt prepared a new edition and German translation.[46]

Ghiberti's terms "form" *(specie)* and "resemblance" *(similitudine)* are linked to individual objects in optical theory. When visual rays enter the eye, they transmit in the act of seeing *(visio)* a form of the object seen, or visible object (*cosa visa* or *cosa visibile*).[47] He refers to the afterimages that remain in the eye in cases of very strong light as "simulacra," but otherwise uses the customary expression *specie* ("form").[48] Now and then Ghiberti adds his own observations in order to stress the likelihood of influence from antiquity. As the effect of light on ancient statues and reliefs proves, artists of that time had applied scientific optical theories "competently," that is, with *doctrina, arte,* and *magisterio.*[49] He notes that ancient sculptures were carved with such subtlety that the carving could usually not be per-

ceived except by running one's hand along the surface, although it became visible in strong light. As a sculptor Ghiberti could study works of sculpture from antiquity directly, whereas before the discovery of Pompeii, painters had to be content with ancient texts and descriptions.

For Ghiberti, fine arts was a distinct discipline, an independent field of knowledge. In the second book of his *Commentaries* he writes that he was always searching for answers to the question of how our visual impressions originate. He wanted to reconcile art and optics because art provided him with a laboratory in which knowledge could be expanded by means of practical experiments. The making of pictures had to be transformed into "art" in order to keep pace with science. At the end of his life, he revealed in the third book that he wanted to make optical science the foundation of a new art.

In book two he brings up the topic of the doors for the Baptistery in Florence—later called "the Gates of Paradise" by Michelangelo—on which he worked in the 1430s.[50] He had conceived the crowded scenes, Ghiberti reports, in such a way that the eye could see them in correct proportion *(misura).* This process would be possible only if he used the right scale. He refers to each of the panels in the door by the same term that artists used for a painting, *quadro.* Each side of a *quadro* measures one and one-third *braccia* (a *braccio* is 58.4 centimeters long). In the panels he took pains "to imitate nature" and create a "network of lines [*lineamenti*] as is needed for a construction in perspective."[51] Yet his attempt to test the rules used for painting in a relief confronted him with new problems, for he had to create a sense of proximity and distance using different heights of relief. His solution consisted of "giving the impression of high relief" where the pictures in fact have "a quite low relief." The human figures in the background also needed to be smaller, "just as reality teaches us" *(adimostra il vero).*

Measurement and the use of relative dimensions were for Ghiberti the key to guiding the eye correctly in the perspective space. This was why, he writes in book one, he strove to imitate artists of antiquity, who always used particular ratios. Ghiberti's scenes contain human figures and allusions to narratives, however, unlike Brunelleschi's diagrams, which limit themselves to architecture (see p. 166). In Ghiberti's reliefs architecture is a counterpoint to the story, but it also provides a framework for the overall geometry of the panel. He successfully used the perspectivist model in Alberti's sense (see p. 169) in only one panel, the one that depicts the story of Jacob and Esau; it also happens to be the one on which Ghiberti placed his signature (Fig. 53).[52] Yet even here there are problems enough. The orthogonals do not recede to the observer's horizon but to a point above the human

Figure 53: Jacob and Esau, panel from Lorenzo Ghiberti's door to the Baptistery in Florence (1430–1437), with superimposed diagram from Martin Kemp, The Science of Art (Scala / Art Resource, New York; diagram courtesy of Martin Kemp, after The Science of Art: Optical Themes in Western Art, Yale University Press, 1990).

figures. The distance point is not coherently related to the vanishing point. And the new set of rules is followed only in the floor tiles, which stand in a ratio of one to three to the figures in the foreground. Everywhere Ghiberti leads the eye to dimensions that are harmonically related to one another but not linked to the action taking place in the foreground.

Ghiberti included a self-portrait on his first door for the Baptistery, the north door, at about the same time that Brunelleschi first publicly "demonstrated" perspective in front of this building (see p. 166).[53] In his *Commentaries* Ghiberti emphasizes that he spent eighteen years alongside Brunelleschi working on the dome of the cathedral and that he wanted to collaborate with him on a treatise on architecture.[54] Otherwise, however, they were competitors and their relationship was strained. While Ghiberti had defeated Brunelleschi in the competition to design

the north door of the Baptistery, the latter was the victor in the official legend concerning the invention of plane perspective (see p. 164).

The situation was different for Piero della Francesca (ca. 1415–1492), who belonged to the generation for whom perspective was already an established method. This painter, who had been trained as a mathematician, was the first artist to write a treatise on perspective, *De prospectiva pingendi.* In the first book, he writes, "We will speak of points, lines, and flat surfaces"; in the second "of cubic bodies, square pilasters, and of columns with more sides." Finally the third book, he writes, will cover human heads and capitals of columns. In his introduction Piero notes that he has used the scientific theory of optics as his model. First and foremost, perspective deals with "seeing, that is, the eye"; it teaches how to depict "the form of the thing that is seen" and "the distance from the eye to the thing that is seen," for "lines lead from its *outline* to the eye."[55] Alhazen was concerned with the *surfaces* of objects, whereas now the basis of the theory has become three-dimensional vision.

Piero repeats the familiar arguments of visual theory; what is new in his work is what we today would call "the screen"—the plane "that is between the eye and the thing seen where one intends to place things." Piero uses the word *termine,* "boundary," an expression borrowed from geometry. *Termine* denotes a third location between the eye and objects, the location of the perspective picture, where the rays of the "visual pyramid" are intersected. Only on such a screen or plane is it possible to calculate systematically how objects are foreshortened by our vision.[56] The plane is a projection screen that reacts to the observer's location when he moves higher or lower, backward or forward.[57]

A key to Piero's geometrical thinking is his concept of *commensuratio,* a Latin term that has survived in Italian and in the English words "commensurate" and "commensurability." It means both "measurement" and "comparative measurement." Piero simply equates the term with perspective. Only through measurement can one assign to objects the place in a painting that they also occupy in reality.[58] The human eye perceives three-dimensionally, and perspective helps us to see painted objects that way, since painting "is nothing but the demonstration of surfaces and bodies foreshortened or enlarged" on the screen.[59] Such a radical statement about art had never been made before, and it was a new triumph of the post-Islamic theory of vision. Visual geometry, if one may describe it as such, constitutes what Bernard Berenson referred to as "the ineloquent" in Piero's art. The human figures in his paintings have a mute presence that is all the more striking

for that reason. It is sufficient that they solemnly occupy their places in the picture, like the three human "columns" in the foreground of his *Flagellation of Christ* (see Fig. 68).

For Piero, measurement was the key to compensating for the weaknesses of the human eye, so that we might see empirically and correctly. To judge depth, the eye needs "a continuous, intervening series of regular objects." As John White observes, in artificial perspective "the first operation is the establishment of a regularly subdivided and diminished, rectangular pavement to provide the necessary measuring rod."[60] Measurement alone provides protection from the traps of perception, as Pelacani had already observed (see p. 148). Through the use of measurement Piero introduces the comparative view that he calls "proportion." Euclid's formulas allowed Piero—who thought of objects in terms of geometry, in any case—to analyze their forms and thus represent them. Piero no longer wanted to separate the *form* and the *visual form* as the theory of optics had done, but rather to think of them as a unit.

Piero requested that the library in Urbino shelve his text on perspective next to his essay on the abacus and arithmetic. The proximity of the two books emphasized the unity of art and mathematics that had been the goal of his life.[61] His third book, a text on the "five regular solids," is pure mathematics and strives to achieve a synthesis with Euclid's geometry, for Piero viewed himself as carrying on Euclid's legacy. Piero bases perspective on universal and absolute rules, which lend a hermetic beauty to his paintings.

Geometry supplied the proportions with which Piero translated the world into art. It constitutes the subtext of his painting, even in the *Flagellation of Christ* and its mysterious subject, which is discussed in the next chapter (see p. 183). According to Martin Kemp, the small rectangular painting is exactly one *braccio* high, and this unit determines the other measurements. The width of the painting is equal to the diagonal of a square measuring one *braccio* on a side. A *braccio* also provides the dimensions of an invisible square with which the vanishing point and the horizon are calculated. Mathematical calculations even enter into the treatment of light and shade: in the colonnade the angle of the light source matches that of Christ's gaze.[62]

Piero's light, like his geometry, is always tied to bodies and physical objects. They construct the space just as, conversely, the view of them is dependent on space. No artist ever paid more attention to stereometry, the dimensions and volumes of solids, than Piero: "A solid object has three dimensions: length, width,

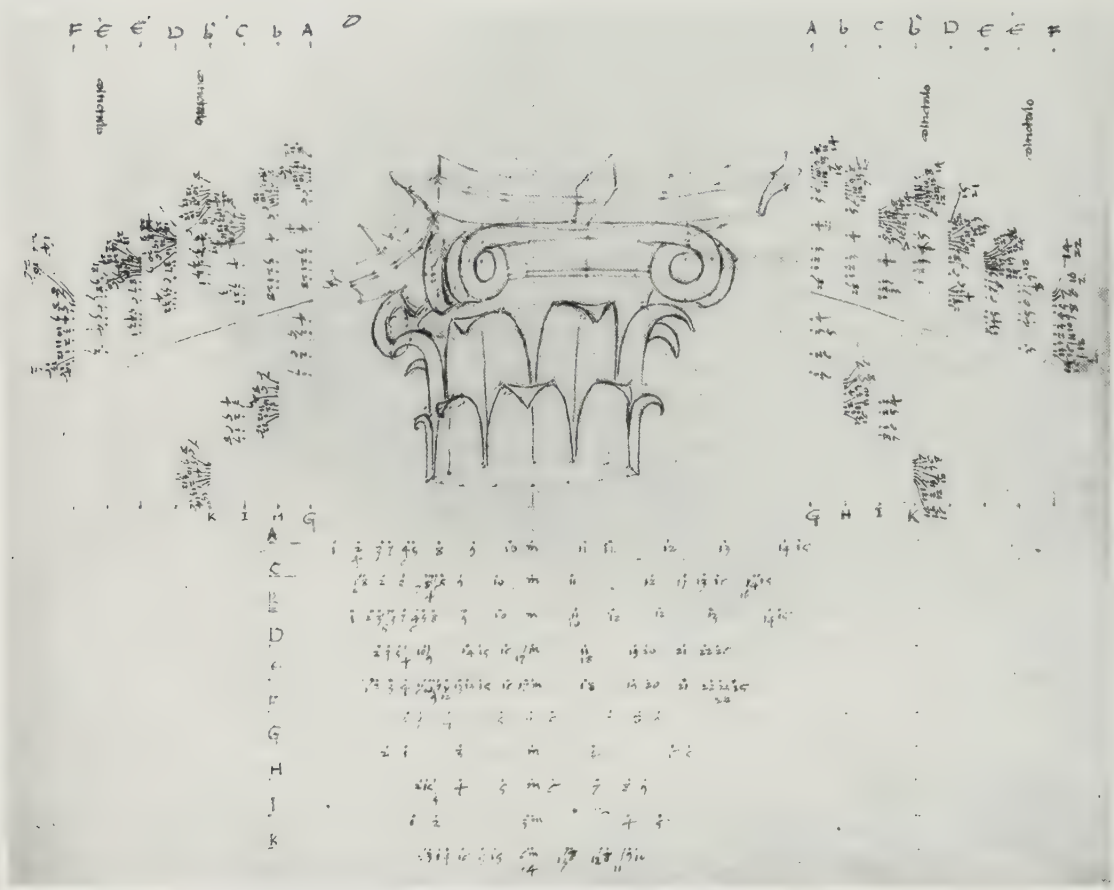


Figure 54: Piero della Francesca, sketch of a column capital in De prospectiva pingendi, fifteenth century, Italy.

and height. Its boundaries are the surfaces. Such bodies have diverse shapes," including cubes, spheres, and prisms.[63] While this geometrical principle is the nature of things and also the essence of things in nature, Piero preferred to depict man-made objects, such as columns, the bases of columns, and pillars, to naturally occurring forms. He could more easily use them to demonstrate his conviction that we perceive the world visually in terms of geometry because that is how the physical world is constructed. The dimensions of his painted columns and buildings were so precise that architects used them as the basis for their three-dimensional designs.

In his treatise on perspective Piero introduces every problem with a sketch and a detailed stereometric calculation that he explains in long columns of numbers.

He does this not only when he is dealing with the capitals of columns from classical antiquity (Fig. 54) but also for depicting human heads in full face, in profile, from above, and from below, including a cross-section of the neck (Fig. 55). His instructions indicate a procedure for measuring all kinds of heads, no matter how different they may be. The process succeeds best for buildings, however, since here the geometry of visual rays on their paths through space can be seamlessly joined with the geometry of a man-made structure's dimensions in space. In both cases Piero "draws lines between points" that he identifies with letters and numbers: In one instance the lines represent distances and angles of vision, and in another the dimensions of the structure itself. The same lines perform different tasks: the measurement of space here, the dimensions of objects or bodies there, even though Piero has ceased to distinguish between them (Fig. 56).

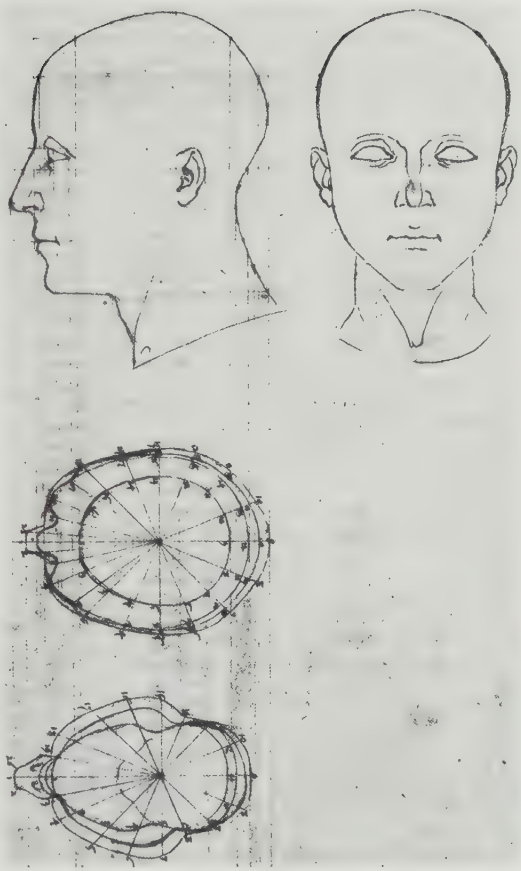


Figure 55: Piero della Francesca, sketch of a head in De prospectiva pingendi, fifteenth century, Italy.

Pelacani's philosophy has never been more consistently translated into art than in Piero's work. In making this claim, one must not assume that the painter had encountered Pelacani's name in his study of mathematics, for the mathematician's views had become accepted by Piero's time. Proportion was already a central method of measure for Pelacani. He derived the topology of space from the fact that objects in three-dimensional space can be measured. If, as Pelacani writes, reality "can always be described in terms of numbers and proportions" (see p. 148), then Piero is consistent and fills his sketches with long columns of numbers.

Western visual culture found its paradigm in the mathematical "visual image" of perspective. Thus Piero anticipates digital processes when he subjects the physical world to a rigorous mathematical deconstruction only to then reconstruct it in the disembodied medium of painting. Contemporary 3-D animators seek to accomplish the same thing as Piero's measuring system—namely, to simulate an

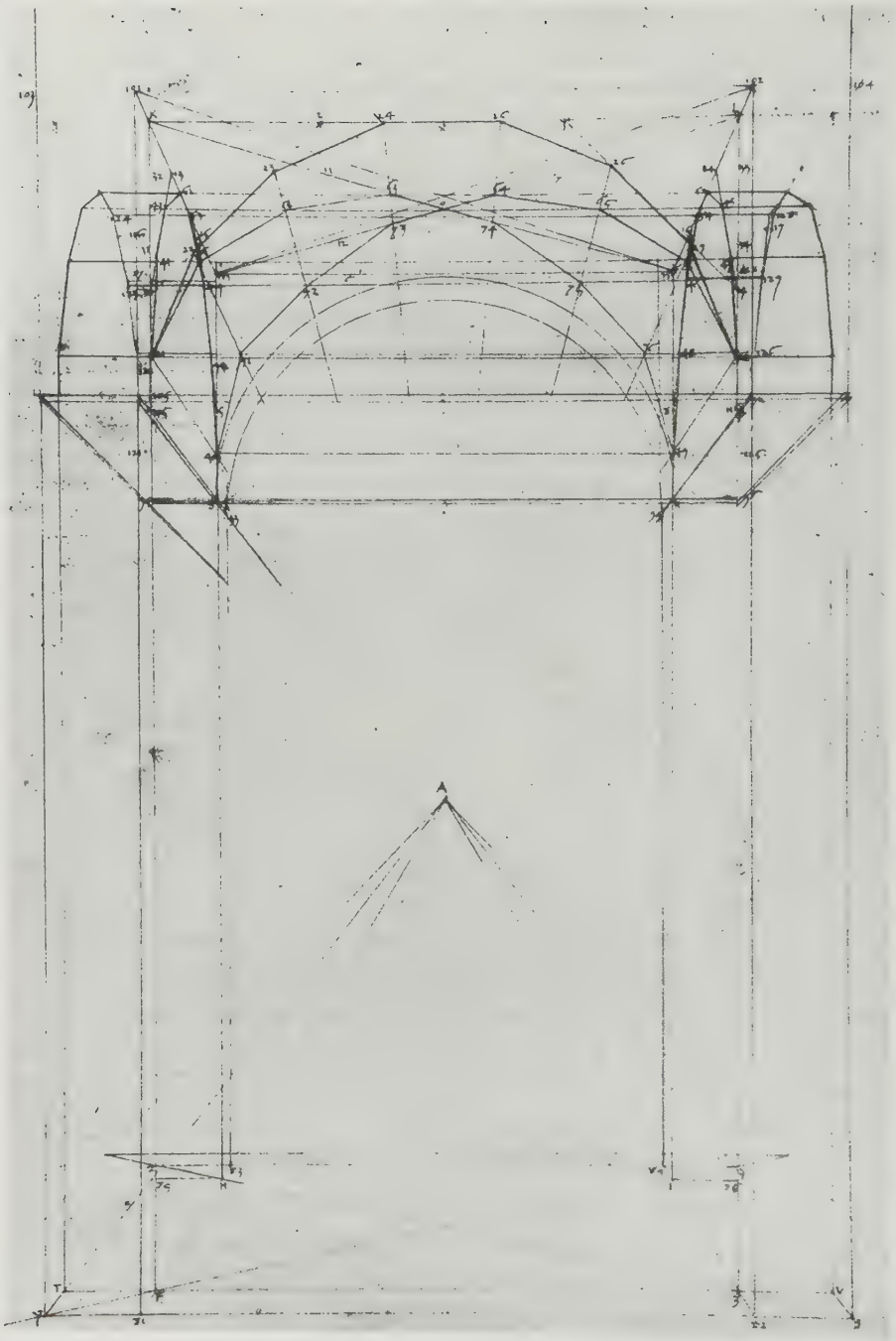


Figure 56:
Piero della Francesca, sketch of a cross vault with vanishing point in De prospectiva pingendi, fifteenth century, Italy.

enormous variety of natural forms—although they use the different and equally artificial medium of electronics.

Blickwechsel: Alhazen or Euclid? The Option for Vitruvius

Piero della Francesca turned to Euclid's geometry in order to quantify things with it, a task for which Euclid was better suited than Alhazen. As his text on points and lines proves, Piero studied Euclid at a time when the latter's work was known only in a translation from Arabic. In one of the first drawings in his treatise on perspective he gave the parallelogram an Arabic name.[64] Yet there is another path by which we can approach Piero's interest in Euclid, namely by way of the great mathematician Luca Pacioli. He is presented in a Venetian portrait dated 1495 (now in Naples) as the Euclid of his day (Fig. 57).[65] Luca and Piero both came from San Sepolcro, and Luca himself edited Piero's writings. In the painting Pacioli is shown demonstrating a geometric problem with a circle and a triangle drawn on a slate tablet; the problem is one Euclid described in the twelfth book of his *Elements.* His left hand is pointing to precisely this passage in a printed edition of the work. Lying in the foreground is Pacioli's own handbook of mathematics, the first of its kind. A transparent polyhedron, one of the "regular bodies" on which Piero wrote a treatise, is hanging from the ceiling of the dark studio. Albrecht Dürer may have seen the portrait in Venice, where it was painted, for his famed copper engraving *Melencolia* seems to have been partly inspired by it.

Finally, Piero's discussion of the geometrical point is Euclidian. Every line proceeds from a point and occupies a particular angle with regard to it. Thus if this point *(A)* is the eye, then everything that reaches the eye or proceeds from the eye stands at an angle to it.[66] Lines must be defined just as geometrically as the eye in perception. The geometric rigor reaches its height in the equation of the eye with a point, since it ignores anatomy. Alhazen speaks of *points in the eye,* which correspond to points on the surfaces of objects, while for Piero the eye itself is a geometric point like other points used in taking measurements. In his sketch of the cross vault it is labeled with the letter *A* (see Fig. 56).

Piero did not want to construct pillars and capitals in the ancient style but to measure them as they had been seen in antiquity. It was his wish to train a kind of gaze that had been lost since antiquity. In contrast, he did not pose any questions

Figure 57: Jacopo de' Barbari (?), portrait of Fra Luca Pacioli (1495), Museo di Capodimonte, Naples (Erich Lessing/Art Resource, New York).

about the ancient origin of the new perspective. Lorenzo Ghiberti took a different approach and made an effort to see perspective as another instance of the rebirth of antiquity, even though he had read Alhazen. In the third book of his *Commentaries* Ghiberti regularly includes "Alfantem" (his corrupted version of the name) among the "many ancient philosophers and mathematicians" he cites. He was familiar with a fourteenth-century Italian version of Alhazen's chief work, entitled *Perspectiva,* that was translated from the Latin text. This translation into the vernacular reflects the interest taken in the subject by artists of the time.[67] There is a manuscript copy of it in the Vatican that also contains geometric illustrations.[68] Ghiberti filled pages with excerpts from Alhazen's texts, but he did not ask himself if he was in fact dealing with an authority from the Arab world, be-

cause his entire worldview was focused on the rebirth of antiquity.[69] Like many of his contemporaries he failed to see the contradictions between Alhazen and Euclid, although scholars such as Pelacani could identify them. Ghiberti simply appropriated the Arab theory of optics and declared it part of ancient tradition.

For this reason he also had no scruples about tracing the origins of the new perspective method back to antiquity. To prove this genealogy, he rewrote an ancient legend that Pliny tells in his lives of the artists. In Pliny's account the famous Greek painter Apelles once called on his colleague Protogenes, who was not at home. The visitor painted an outline of the greatest fineness *(summae tenuitatis)* as a kind of visiting card. When Protogenes discovered it, he painted an "even finer line" *(tenuiorem lineam)* next to it in a different color. Apelles refused to acknowledge defeat, however, and on his next visit he took up another color and painted a line between the outlines so fine that no room was left for anything finer."[70] Ghiberti reworks this legend so that in Protogenes's absence, Apelles took "the brush and completed [his picture] with a composition in perspective."[71] The term "perspective" does not occur in the ancient text, nor is there any description of a painting, in the sense known in the Renaissance, to be found. Ghiberti simply converts the enthusiasm for fine lines in Pliny's text into a perspective composition.

To support his claim that perspective goes back to antiquity, Ghiberti also turns to Vitruvius. In his eyes the Roman author's description of *scenography* offered conclusive proof that practical use had been made of mathematical perspective in ancient times. That is not the case at all, however. If we exclude stagecraft, a true concept of perspective did not exist in ancient times, nor was there any independent theory that corresponds to it, as even Panofsky was forced to admit."[72] When Ghiberti comes to speak of the proportions of the human figure at the end of book three, he quickly takes the opportunity to bring Vitruvius into the discussion. Perhaps he was the first to reconstruct "Vitruvian man" inside a circle, as a circular gap in the page suggests.[73] Ghiberti felt close to ancient perspective in Vitruvius's text on stage scenery, and he describes ancient scenography as the transfer of a three-dimensional view to a surface. "If we establish a certain point at the center [*luogo certo al centro*]," Ghiberti writes, quoting Vitruvius, then the lines correspond to nature. Certain images *(imagini)* of buildings can be created that "reproduce the uncertain reality [*incerta re*] of the visual form [*specie*]."

Ghiberti cites the text but makes a significant alteration, saying that the perception reproduces "a particular reality" *(di certa cosa);* this was why the painted

pieces of scenery appeared "as if they came forward at one place and extended backward at another." The set painters of antiquity adapted "the outlines of things to the view in an eye at rest."[74] In the Renaissance, "scenography" was a controversial term. Some, like Vitruvius, understood it as a ground plan *(ichnographia)* or front elevation *(orthographia)* of a building, or even as a cross section. Raffael interpreted it as an interior view, Fra Giocondo as an external view, and others as a combination of front elevation and cross section. In his handbook on architecture Serlio puts an end to the long debate by declaring: "What Vitruvius calls *scenography* is perspective."[75]

In this new orientation, the shadow of Alhazen paled in the glare of classical antiquity. His theory was by then considered common knowledge, so that no one remembered how much they owed to his work and his name. In the same way that ancient buildings were being reconstructed, so too was speculation flourishing—despite Alberti's cautiously expressed skepticism (see p. 230)—about an ancient science of perspective. But it had never existed, and the attribution was based on wishful thinking.

The genealogy described here makes use of a wealth of evidence but nevertheless lacks a contemporaneous document specifically linking Alhazen, Pelacani, and the debate on perspective in Florence. The addition of two names to the literature on perspective will have to suffice, great men who altered the genealogy of science and art, especially in the encounter between two cultures.

The "infidels" in the East could not compete with the claim that the legacy of perspective came from classical antiquity. They also played no role in the issue of pictures that gave rise to a new art in Western culture. Yet the Arab theory of optics provided the West with an essential tool, if we think of the geometry of visual rays and the measurement of light. Once this was transformed into a pictorial theory, the two cultures were even further apart than had been the case in the Middle Ages. In the decorative arts their proximity was greater, as we have seen, because the issue of pictures was not involved. One of the greatest paradoxes in this encounter between East and West is that perspective art in the nineteenth century was introduced in the Islamic region, against enormous resistance, just as modern art was about to arrive on the scene. The resistance can be explained by the fact that perspective made the issue of pictures unavoidable.

An anthropocentric world presumes the existence of an observer who occupies a fixed position; "being-in-the-world" is transformed into "gazing-at-the-world." The observer's body is in the world, but he faces the world with his gaze from a position that he himself chooses. Here we have the foundations of a conflict that

would lead to what has been called *ocularcentrism* in our times. The Renaissance used the phrase "bodily eye" but actually meant the *disembodied gaze,* whose emblem became the eye (see pp. 211–221). The eye offered the gaze control over the world. The perspective painting became a symbolic mirror in which the gaze depicted itself.

5

Brunelleschi Measures the Gaze

Mathematical Perspective and Theater

Two Inventors in Florence

For Florentines, that linear perspective was invented in their city is not a belief but incontrovertible fact. The invention was demonstrated in two experiments by the architect Filippo Brunelleschi (1377–1446), a goldsmith by training, who conducted them in front of the cathedral and the Palazzo dei Signori using painted views of both places. Legends sprout up around great inventions, as people tell stories about what they cannot explain. The invention of plane perspective is no exception: it became the subject of a patriotic narrative that demanded a protagonist and hero.[1] How much of it is truth and how much fiction? If we rely on witnesses to Brunelleschi's invention, we can say at least that it was accepted without controversy in Florence.

One of the first witnesses is a humanist to whom we owe the first theory of plane perspective, Leon Battista Alberti (1404–1472). A generation younger than Brunelleschi, he came to Florence in 1428 when an earlier order that had banished his family was rescinded. In 1436 Alberti dedicated the Italian version of his textbook on painting to the "architect Pippo," as he called Brunelleschi.[2] Although he does not mention Brunelleschi's "demonstrations," he leaves no doubt that the architect Filippo deserved credit for the invention: "He invented arts and sciences of which people had formerly heard nothing and seen nothing, and had no model for them." Because Alberti dedicates his book on painting to a man who was not a painter, it is clear that what concerned him was a new "art" with "mathematical content," as he writes.

Brunelleschi was also the first artist to have a biography written about him. It forms the basis of the *true legend,* so to speak, and was presumably written by Antonio di Tuccio Manetti (1423–1497), a scholar known to have studied mathe-

matics—geometry in particular—and astronomy. A manuscript copy of Dante's *Divine Comedy* from 1462 has a drawing in his hand "elucidating the geography of the *Inferno.*"[3] Manetti affirms that Brunelleschi "propounded and realized what painters today call perspective." It is a "science" *(scienza),* which consists of "setting down properly and rationally the reductions and enlargements of near and distant objects as perceived by the eye." The new kind of art is "not . . . without reason" called a science, since its true significance lies in making figures and objects appear "in correct proportion to the distance in which they are shown." Its discovery is all the greater *(ed è piu forte)* since "we do not know whether centuries ago the ancient painters . . . knew about perspective . . . If indeed they employed it by rule . . . whoever could have imparted it to him had been dead for centuries."[4]

The city of Florence honored Brunelleschi with a public memorial on the wall near the entrance to the cathedral, where he had carried out his first experiment with perspective (Fig. 58). The architect is depicted looking out toward the piazza in front of the church. If we can believe Vasari, Brunelleschi's pupil and adopted son, called "Il Buggiano," made the very faithful marble portrait.[5] The mask still exists, in fact, that was made in 1446, immediately after the death of the famed son of the city.[6] The inscription praises Brunelleschi as a new Daedalus whose inventions showed "divine genius"; the construction of the cathedral dome was his greatest achievement. The art of painting deserved a similar memorial, and so several decades later, in 1489, Lorenzo the Magnificent had one to Giotto placed on the same wall (Fig. 59). Although Giotto had not invented perspective, he had created a new kind of painting. In the inscription, which mentions his contribution to the bell tower of the cathedral, Giotto speaks in the first person, saying: "I am the one who revived the dead art of painting."[7]

Finally, Brunelleschi occupies a key position in a painting, now in the Louvre, that portrays five men and is attributed to Paolo Uccello (Fig. 60). The work belonged to the architect Giuliano da Sangallo and depicts the "five most famous men of Florence," in Vasari's phrase.[8] The patriotic honor may have been suggested by Manetti. His name was later written next to one of the figures, but it is more likely a portrait of Masaccio, a Florentine artist who died young. These five artists established the city's fame as the cradle of a new kind of art. The series of portraits begins with Giotto, as precursor, and ends with Brunelleschi, who represents its culmination, that is, with the two artists to whom the memorials in the cathedral were dedicated. In modern terms we would speak of a tribute to the

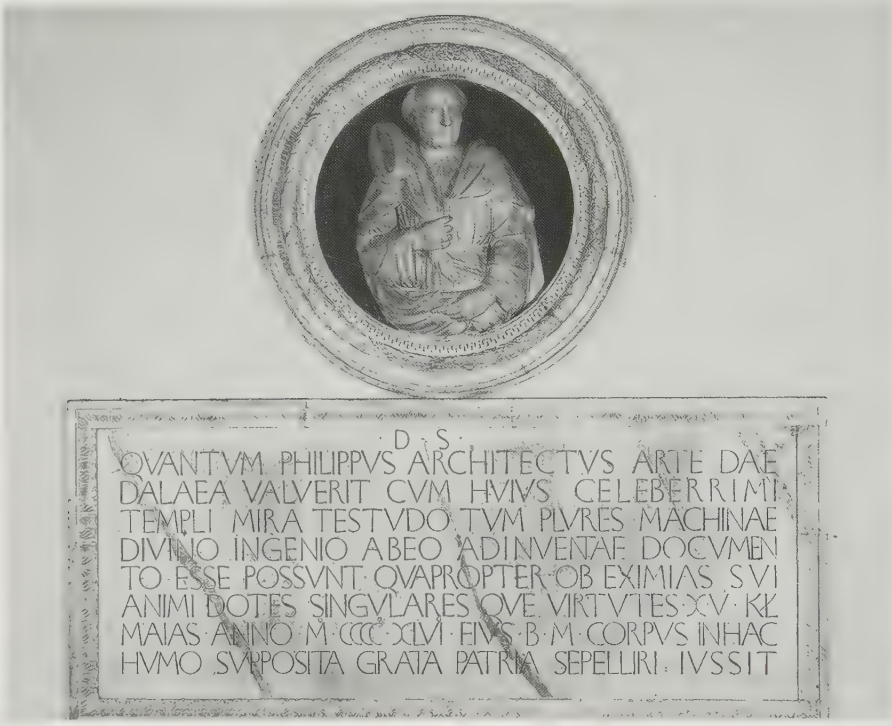


Figure 58: Memorial to Brunelleschi in the Florence Cathedral, made by his adopted son, called "Buggiano," after 1446 (Opera di Santa Maria del Fiore, Florence).

avant-garde. The inventors of *prospettiva* were thus commemorated like writers and scholars, whose disciplines had long been defined as "liberal arts." Now painting joined them.

Manetti describes the public experiments that Brunelleschi undertook in Florence as the founding acts of perspective. The first "demonstration" was carried out with a small square painting measuring "half a *braccio*" (29.18 cm) on each side. Manetti wrote that he had often held it in his hands after it became a precious artifact to other artists. This momentous work depicted "the exterior of San Giovanni in Florence," the Baptistery that faces the cathedral, "encompassing as much of that temple as can be seen" from one spot (Fig. 61). The structure was painted "with such great precision in the black and white colors of the marble that no miniaturist could have done it better." In fact miniaturists often used the Baptistery as an emblem of Florence in illuminated chronicles of the period.

On the painting "he placed burnished silver where the sky had to be repre-

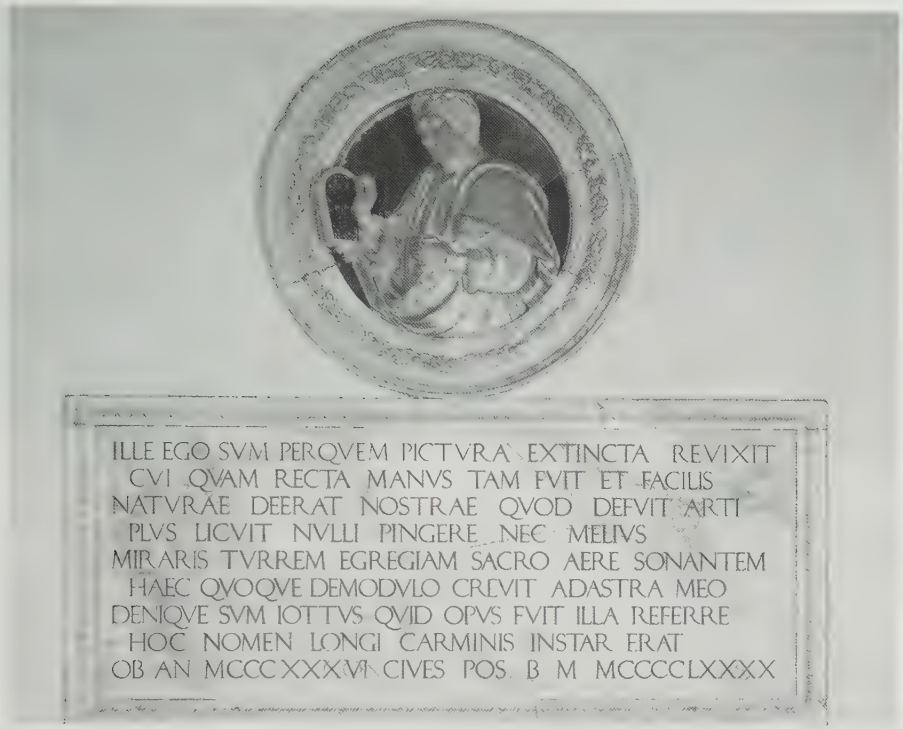


Figure 59: Memorial to Giotto in the Florence Cathedral, 1489 (Opera di Santa Maria del Fiore, Florence).

sented, that is to say, where the buildings of the painting were free in the air, so that the real air and atmosphere were reflected in it." The clouds, which cannot be measured in perspective, were "carried along by the wind as it blows." The demonstration took place "some three *braccia* inside the central portal of Santa Maria del Fiore," that is, at a point fixed in advance. Brunelleschi thus ensured that "no error would be made in looking at it (since any point outside of that single point would change the shapes to the eye." If he established the distances between the painting, the mirror, and the Baptistery itself, then he could mark the spot at which the experiment with a painted projection would succeed.

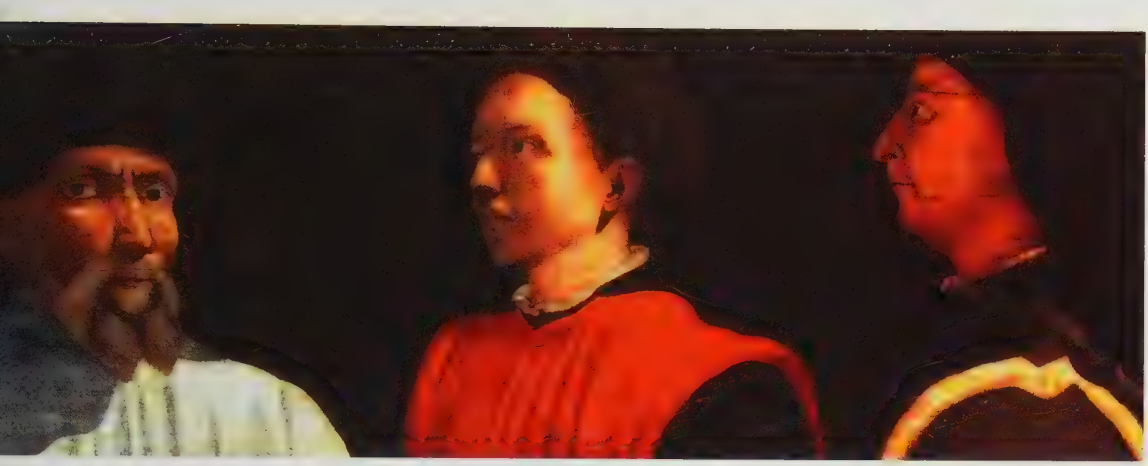
For the public the painting and the actual structure merged at this spot as if by magic, since the work of art seemed to reproduce reality itself *(el proprio vero)*. The observer had to hold up the painting in front of his eyes, facing away from him, as if the painting were itself a human subject with a gaze. He then looked through a pinhole in the painting, while holding a flat mirror *(uno specchio piano)* at arm's length. What he then saw was the front of the painting, or actually a mir-

Figure 60: Paolo Uccello (?), Five Famous Florentines, ca. 1460, Louvre, Paris. From left to right: Giotto, Uccello, Donatello, Manetti or Masaccio, and Brunelleschi. They were celebrated as the avant-garde of perspective (Réunion des Musées Nationaux / Art Resource, New York).

ror image of it. Brunelleschi's experiment succeeded only because the painting depicted a building that was symmetrical about its vertical axis.[9]

The painting, which included a mirror and acted as a metaphor of the mirror, brought the optical theory of the time into play. Its laws were already *mathematical,* but now they became *iconic.* In the words of Filarete, Brunelleschi "discovered the method of making this plane . . . from what the mirror shows you."[10] The eye was the same distance from the painting as from the surface of a mirror, and in the mirror the distance point behind the glass appears to be doubled as well. In a flat mirror made of glass, an innovation from Venice, the gaze was reproduced more clearly than had ever been possible in the matte, polished metal mirrors of antiquity. The new type of painting was a mirror of a special kind. In contrast to actual mirrors, it did not show one's own face, for when the observer approached the pinhole he was invisible standing behind the painting. But the painting lived from the presence of an observer who recognized his own gaze in it. The mirror was no longer a site of deception but the site of a new truth about seeing.

According to the mathematician Brian Rotman, "Euclidean space . . . is radically different from a projected, coordinated space," a space in which every point can be signified in relation to the horizon, centric ray, and vanishing point. "The mathematical space appropriate to perspectival images is that of projective geometry," which must establish all positions on the drawing plane. The painter "imagines lines in space," and "where these lines intersect the screen he makes his marks." These signs "represent continuously point for point, the surfaces of things within the visible world." It is here, I would like to add, that lies the real attempt to manifest the theory of optics in a static image. Such an image depends on the



belief that it arrests our gaze, as photography would do later. In a perspective painting, Rotman stresses, among all these points or signs "there is one . . . with a uniquely privileged status." The point "where Brunelleschi must have made his pinhole . . . is known as the *vanishing point* or 'point of flight.' And it is this sign which organises the perspectival image for the spectator." Like zero, the vanishing point is in one sense just one sign among others. Yet at the same time, again like the sign zero that had been introduced not long before Brunelleschi's lifetime, it is an exceptional kind of sign, since its function is to coordinate the other signs "into a coherent unified image." The vanishing point "functions as a visual zero facilitating the generation of an infinity of perspective images as zero generates an infinity of Hindu numerals."[11]

Let us now turn to Leon Battista Alberti, the second Florentine to whom the invention of perspective was ascribed, and take a closer look at his famous text. Alberti completed his three books on painting in Florence on September 7, 1435. In them he introduces the mirror as the best judge for painting and as the way to correct what we see in nature (*iudex optimus speculum,* II.46), "since we measure all things [*res omnes*] by our own gaze" *(intuitu metimur)* (I.5). The mirror effect requires, however, that painters "establish a fixed viewing point [*prospectum terminum*] in their painting" (II.32).[12] Through this, the *factual distance* at which we stand from the canvas is transformed into the *fictional distance* to a painted world. It is only this transformation that enables us to equate the image with reality. Whereas the visual theory investigated the distance to a *real object,* the pictorial theory calculated the *object in the picture,* so that we see things that are not there at all as if they were present.

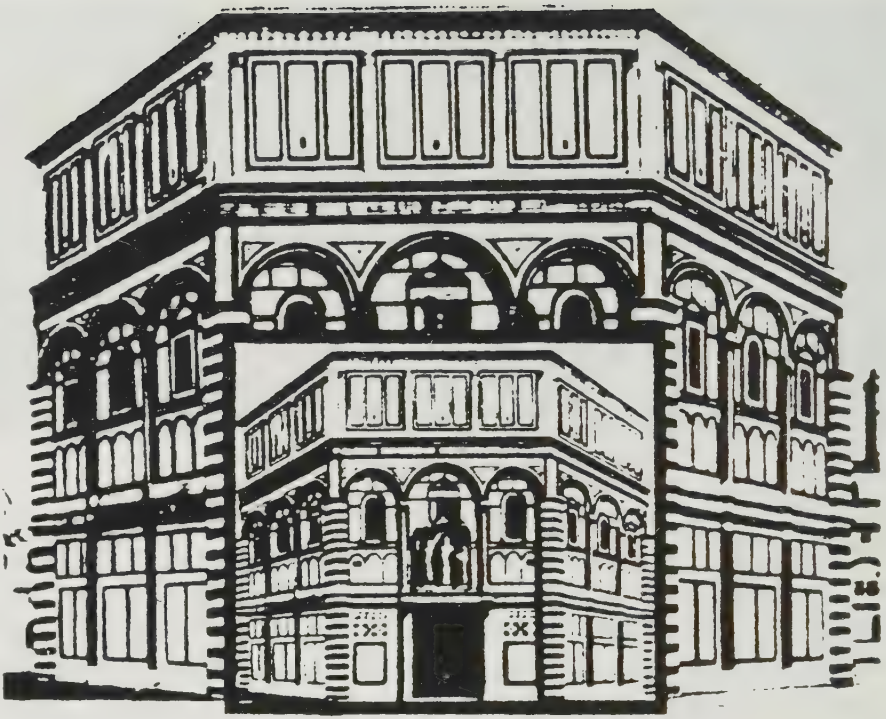


Figure 61: A simulation of Brunelleschi's first demonstration of perspective, with the Baptistery in the background and a mirror view of it in the foreground (schematic courtesy of Brian Rotman, after Brunelleschi; from Brian Rotman, Signifying Nothing: The Semiotics of Zero, Stanford University Press, 1993).

In what is known as the visual pyramid, which is constructed of the visual rays, the painting is inserted between the eye and the object—the painting, that is, consists of a plane intersecting the pyramid (see Chapter 1). It is this painted screen that transforms changing "visual forms" into a "visual image" that becomes concrete, so to speak, in the static object. Pictorial theory is applied visual theory, for perspective paintings show the world under the conditions of our vision. The *distance of the eye* is a domain of the gaze in this process and is distinct from the *distance of the observer's body* to the painting. Nevertheless it is tied to a body. The new painting becomes anthropomorphic through this relationship to the body. The quantities measured create a kind of equation between the gaze and the body, to conceal the difference between them. The painted horizon, which corresponds to the eye level of the observer, determines whether the lines of convergence are viewed from above or below—a principle illustrated in the diagram discussed in Chapter 1 (see Fig. 3).

To establish for a painting "the size of the human being" who will look at it, Alberti says, the painter should apply the measure of the *braccio,* since the average

height of a man's body is three *braccia*. If the baseline of a painting is divided into three parts using this measure, then the symmetry is established between gaze and body, something that was always a problem before. The centric point *(centricus punctus)* should be "no higher from the baseline than the height of the man to be shown in the painting, for then the viewers and the objects in the painting will appear to be on the same plane" (I.19). Using the lines of sight, one can verify the distances between the objects in the picture. Yet as Martin Kemp observes, Alberti cannot conclusively prove how the orthogonals are to be oriented. There remains in the picture "a disjunction between visual process and construction."[13] Alberti noticed this, but he had solved the problem for his friends with a geometrical key *(quadam geometrica ratione)*. This consisted of a diagram that he omitted from the book, however, "for reasons of brevity" (I.23). Alberti also demonstrated the correct distance of the eye with his own paintings, "which our friends marveled at, when we did them, and called them 'miracles of painting'" (I.19). As in the case of Brunelleschi, only by a practical demonstration and their own eyes could people be convinced of the convergence between seeing (nature) and seeing a picture (art).

In what way does Alberti now refer to visual theory? He cites the "opinion of philosophers" of the theory, who believed that we see the surfaces of all objects only with the aid of "certain rays," which he calls "ministers of vision" *(visendi ministris)*. Through these rays "the images of things" *(rerum simulacra)* are impressed upon the senses (I.5). By using this term, along with the term *imago* (I.6), Alberti transforms the theory of vision into a new pictorial theory. His topic, the gaze, is that gaze that art represents on the painted surface (I.12). The latter represents the visual image for him. Alberti does not claim to speak as a mathematician "but as a painter." "Mathematicians measure the shapes and forms of things [*species*] in the mind alone [*solo ingenio*] and divorced entirely from matter." He himself wants to place vision in the picture, and for that reason he is seeking "a fatter Minerva," that is, an approach through the senses (I.1). "Among the ancients it was a subject of dispute whether . . . visual rays emerge from the surfaces of objects or from the eye. This question is rather difficult, but we can leave it aside as not useful for our case" (I.5).

Alberti was not able to avoid a conflict with optical theory as soon as he made the (conscious) subject and the gaze his actual topic. The *vanishing point,* on which all the desire to see is literally concentrated, now becomes the point on which everything turns.[14] The spectator is represented *in front of the picture* by the eye point and *in the picture* by the vanishing point. The lines of convergence (or-

thogonals) draw the gaze into an "infinite distance," but this abstract quantity can only be represented in a diagram (I.19). For Alhazen the lines of convergence only *seem* to come together in a vanishing point, as Witelo cites him in his *Perspectiva.*[15] Alberti's achievement consists of actually transcending the finitude of the eye in the gaze and guiding it toward itself in the vanishing point.

The painters' plane perspective could be attained easily only in the *pavimento,* the tiled floor in their pictures. It was a field with straight lines and right angles on which the figures were placed like chessmen (compare Fig. 53). But this created constraints. Alberti speaks in the Italian edition of his work about the way the visual rays "form an enclosure around the entire surface like a cage" (I.7). The attempt to escape from this "cage" ended in more or less obvious deviations from an overly rigid geometry. Yet the problems were not only aesthetic but also scientific. In the long term, artists could master them only by seeking alternatives with distortions at the edges, in curvilinear perspective, or with a bifocal view. Experiments with aerial perspective and with atmosphere in sfumato pointed in a similar direction.[16]

Alberti nevertheless referred repeatedly to visual experiences from everyday life. Nature clearly demonstrates, he writes, that "in churches we see the heads of men walking about, moving at more or less the same height, while the feet of those further away may correspond to the knee-level of those in front" (I.20). Nonetheless an unbridgeable gap remained between the *process* of seeing *(visio)* and the visual image in perspective *(pictura),* not least because art was concerned with images and not in search of new evidence for perception. As a result art's alliance with science was of limited duration. In the third book of his work Alberti himself developed a theory of art that expanded or even replaced the pictorial theory of the preceding two books with an idea of rhetoric understood in a humanistic sense.

But let us return to Brunelleschi, the architect. One should not forget that in the invention of perspective he made use of a measuring process that had long been in use in his own field of architecture. When he and Donatello studied the ruins of Rome they wanted to reconstruct the original dimensions of ancient buildings, but the fact that they were digging on their own initiative aroused suspicions that they were "treasure hunters." His drawings on parchment with their notations of dimensions were nothing other than perspective views of the ancient structures.[17] The measurement of architectural monuments thus preceded the measurement of vision in painting.

At that time, however, the avant-garde was fixated not on the real Rome but an

imaginary one. In Florence Brunelleschi chose a highly symbolic site for his experiment with perspective. The Baptistery of the cathedral was where all Florentines had been christened and it was named after the city's patron saint, John the Baptist (see Fig. 61), but it was also considered the oldest building in the city, an emblem of Florence. According to legend, the "*bel* San Giovanni," as Dante referred to it, had been a pagan temple before its conversion into Christian church.[18] It must have seemed to Brunelleschi that he could almost capture antiquity itself in this structure, as if in a visual image. Antiquity was resurrected, so to speak, in a painted view of a Florentine piazza. *Prospettiva* was one of the ways in which the self-declared heirs of classical antiquity wanted to carry on its legacy. Their ascription of perspective to ancient painting could not be contradicted, since at that time all that was known about it came from written descriptions of such paintings, not the works themselves (see p. 152).

Physical Space: The Architecture of the Gaze

In *Architectural Principles in the Age of Humanism,* a book by Rudolf Wittkower, the two guiding principles can be described as *anthropomorphic* and *pictorial.*[19] The first term describes the principle that relates architecture to a human *body,* in which separate members are assembled into a harmonious whole. The second associates architecture with a picture, which demands an observer and becomes anthropomorphized in his gaze. Islamic architecture follows different principles in both respects (see Figs. 41 and 42 and p. 115). Perspective transformed not only painting but also the architecture of its time, so that the reconfigured space of architecture (see Fig. 66) became a space for the gaze just as much as painting (see Fig. 65). And in Florence the Baptistery was discovered as a visual image at the very moment that Brunelleschi used it to demonstrate plane perspective (see p. 166). Nevertheless when Alberti devised a terminology associating the invention of plane perspective with the gaze, he did so only for painting.

Twenty years after writing his treatise on painting, Alberti also became the leading theorist of architecture in his time. Here, however, he submitted almost unconditionally to classical terminology rather than speaking of a new invention. He had what amounted to a blind spot that prevented him from addressing the obvious analogy of painting and architecture. Painters turned to architecture

when they wanted to demonstrate the perspective method; Brunelleschi himself had introduced the invention of plane perspective with views of buildings. As an architect, however, he remained in the shadow of the much younger Alberti, since a theory of architecture formed no part of his legacy. This is why scholars have to rely on Alberti's writings so much, even if the way he built did not follow his predecessor closely at all.[20]

According to Matteo Palmieri, Alberti presented *On the Art of Building in Ten Books* to the pope in 1452—during an audience in which he also mentioned his opposition to the new construction of St. Peter's, as it happened.[21] The always well informed Angelo Poliziano later wrote in a letter to Lorenzo de' Medici that Alberti "was able to grasp every principle of ancient architecture, and renew it by example."[22] Alberti himself expresses regret, in the preface to book six, that so many ancient texts on architecture have been lost: "Almost the sole survivor from this vast shipwreck is Vitruvius." Yet even Vitruvius's writings had many shortcomings, and he wrote so badly that Romans thought he was a Greek and Greeks assumed he was Roman. Ancient temples and theaters survived, Alberti writes, but they were "being despoiled by vandalism." For that reason Alberti had examined carefully every "building of the ancients that has attracted praise, . . . measuring everything, and comparing the information through line drawings."[23] His *Delineation of the City of Rome (Descriptio urbis Romae)* was an attempt to reconstruct the ancient city in a systematic manner, so that everyone could see the extent to which Rome had lost its former appearance. Alberti used mathematical instruments to create site maps, according to which "anyone . . . may make both exceptionally easily, and also very accurately, depictions on any surface, however large."[24]

In the prologue to his work on architecture Alberti writes that a building is "a form of body, which like any other consists of lineaments and matter." The lines existed only in our imagination, being "the product of thought," whereas the matter was produced by nature. Architectural projections are "conceived in the mind" but carried out with "lines and angles."[25] Painters had "to emphasize the relief of objects in paintings with shading and diminishing lines and angles."[26] For the architect, however, some knowledge of drawing and mathematics was indispensable; "he should forsake [them] no more than the poet should ignore tone and meter," for it is often easier to recognize a building from a sketch than a floor plan.[27] Looking back on his treatise on painting, Alberti observes that points and lines are for painters not what they are for mathematicians. "In my definition a

point is a sign that the painter perceives as something in the middle between a mathematical point and a relative size that can be expressed in numbers."[28]

Distance perspective was a requirement not just for painters but also for architects, a fact—often overlooked—that became evident in the architectural drawing, which came into use as a new genre. Such drawings were based on a particular conception of what constituted a picture.[29] Perspective was used in the construction of buildings both as a measuring process and for projection. Only when this double use is recalled does architecture regain its proper place in the invention of mathematical perspective. The theoretician Sebastiano Serlio (compare Fig. 3), who devoted the second book of his standard work on architecture (1451) to perspective, evokes Vitruvius when he distinguishes three ways of representing buildings: *ichnographia* (a layout or ground plan), *orthographia* (the elevation or vertical image of the facade), and *scenographia* (a view showing the facade and a receding side). To make his usage conform to architectural practice, Serlio decided that "perspective is what Vitruvius calls *scenographia,*" and this applied to pictures of buildings as much as to any other objects.[30] A perspective view of a building unites architecture and drawing, since it subjects both to a spatial gaze.

The question of the perspective gaze can be posed with respect to architecture only if we expand the definition of "picture" and extend it to space (three dimensions). Here *space as picture* is for architecture what *space in the picture* is for painting. In the one case space is built, and in the other it is painted, but in both cases it has been designed for a gaze that turns it into a picture. In the plane perspective of painters the visual space before the eyes is an open one, in contrast to the interior space built by architects. This makes the parallel postulated here all the more surprising: a parallel between the way we see in everyday life and the way we see architecture. The quintessence in both cases is commensurability. It creates proportions that we experience as beautiful. The perspective method was developed with the aim of giving form to three-dimensional space. As a gestalt, perspective makes such an impression on the observer that he experiences it as his own idea. This double sense is an indissoluble part of every gestalt theory, and it is so in this instance, too.

The room called the Old Sacristy in the church of San Lorenzo in Florence is an early example of a perspective space proportioned so as to address our sense of our own body rather than one that diminishes us because it is so large. Commissioned by the Medici family, it was the first of Brunelleschi's important works.[31] The wall is divided by pilasters into rectangular fields of view that become half

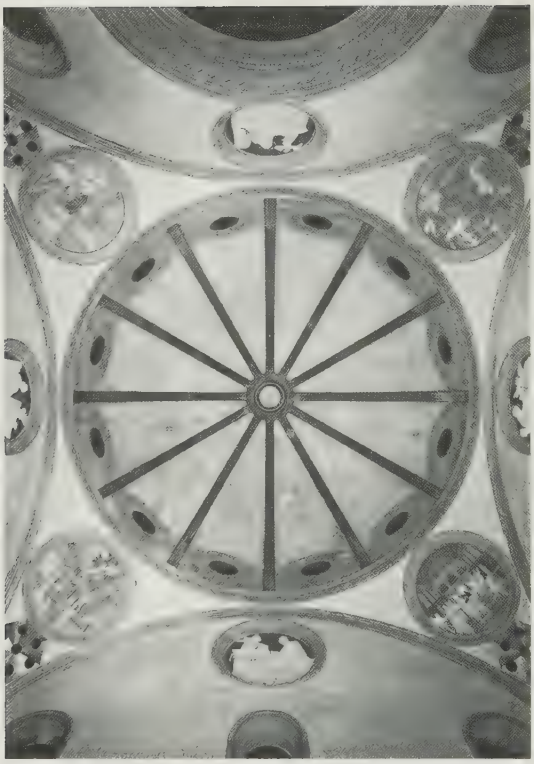


Figure 62: Brunelleschi's dome in the Old Sacristy, San Lorenzo, Florence, 1418–1428 (Alinari Archives, Florence).

Figure 63: View of the altar in Brunelleschi's Old Sacristy, San Lorenzo, Florence (Erich Lessing/Art Resource, New York).

circles above the entablature. A full circle is achieved in the dome, which responds geometrically to the right-angled elements in the lower section of the wall. Its spherical surface can be measured just like the wall surfaces below it, for the dome is also divided into regular segments that the eye can readily take in. Everywhere it finds correspondences between geometrical figures (Fig. 62).

The pictorial character of the room culminates in the choir, which echoes the main room on a smaller scale. It is a picture framed by pilasters and an arch (Fig. 63). The walls and architectural elements are foreshortened, transforming the altar space into a visual image—or one might call it a "prospect" of the main space, in the terminology of the stage (see p. 185). Here the dome (which like the main dome is encircled by a border resembling gathered "fabric") has a smooth surface that has been filled by a painted picture of the starry firmament, which is already represented as the dome of the sky by the full circle at the base. It shows the view of the night sky in Florence on a particular date: July 4, 1442. Hence the dome recalls an earthly and even a local gaze, one that is fixed in time and place. The contrast to the Islamic dome in Granada, which presents the drama of a rotating cosmos as the light changes over the course of a day (see p. 116), could not be greater. In Florence, the character of the painting is completed by the theme, for the stars are turned into ancient gods, who traverse the heavens as constellations.

The Old Sacristy is not only organized as a picture but also exhibits pictures, on two different levels, in spaces enclosed in circular frames. These were filled in at a later time by Donatello, with stucco reliefs whose images alter the effect of the room. These images not only are evidence of competition between architect and sculptor but also express a rivalry between two different conceptions of what a picture is. Donatello's roundels are pictorial narratives that become independent of their surroundings. In the pendentives of the dome they tell stories from the life of St. John the Evangelist. Here Donatello experimented with the new

perspective with a vigor and mastery achieved only by Uccello among contemporary painters.[32] Let us take a closer look at the scene showing the "raising of Drusiana" (Fig. 64). The circular medallion above the Medici coat of arms ties the wall and the dome together perfectly, but Donatello reinterprets the stucco relief as a picture frame, which disconnects the picture from its surroundings. On the stairs of a hall shown in strong red tones, massed figures appear whose white color brings lively contrasting movement into the quiet setting. The perspective succeeds only for the architecture depicted in the medallion, however; the action of the figures resisted depiction in geometrical terms, like the clouds in neighboring scenes.

The artistic partnership of architecture and pictures in the perspective endeavors of the time is confirmed in painting as well. The young Florentine artist Masaccio produced his mural in Santa Maria Novella at about the same time that the Old Sacristy was completed in 1428. It responds to Brunelleschi's formal language sensitively without quoting it literally.[33] The analogy goes further than that, however, for the picture does not merely depict a chapel; it actually occupies the chapel's place in the church (Fig. 65). On one side of the aisle in the Old Sacristy, the wall contains an opening that exists only in the painting. The fiction is complete when the viewer stands at the exact spot in the nave for which the perspective was calculated; the illusion is fully convincing only from there. What we see is neither a plain wall nor a genuine chapel, but a hybrid between painting and architecture. The borders of the fresco, great pilasters in the style of Brunelleschi's *Ospedale degli Innocenti,* look as if they belong to the structure of the main church, while the ionic capitals of the adjoining columns tilt away sharply toward the rear of the imaginary painted chapel.

Figure 64: Donatello, The Raising of Drusiana, Old Sacristy, San Lorenzo, Florence, 1434–1435 (Erich Lessing / Art Resource, New York).

The effect of the trompe l'oeil architecture was even greater while the original altar was still standing before it. It alone occupied the level on the floor of the church on which the observer stands. The imaginary chapel, by contrast, is raised to a level that we can only reach with our gaze, not enter with our feet, so the view from below keeps us at a distance. The donors, a married couple, are shown kneeling before the entrance to the chapel; where others would have a real chapel built they simply had one painted, and hence the task fell to perspective to create the illusion of a genuine space. At that time painters could successfully create the illusion of three dimensions on a flat surface only in relatively small formats, not on entire walls. As a result the visual pyramid is distorted here by the view from below.[34]

The two vanishing points in Masaccio's fresco prove that an empirical perspec-

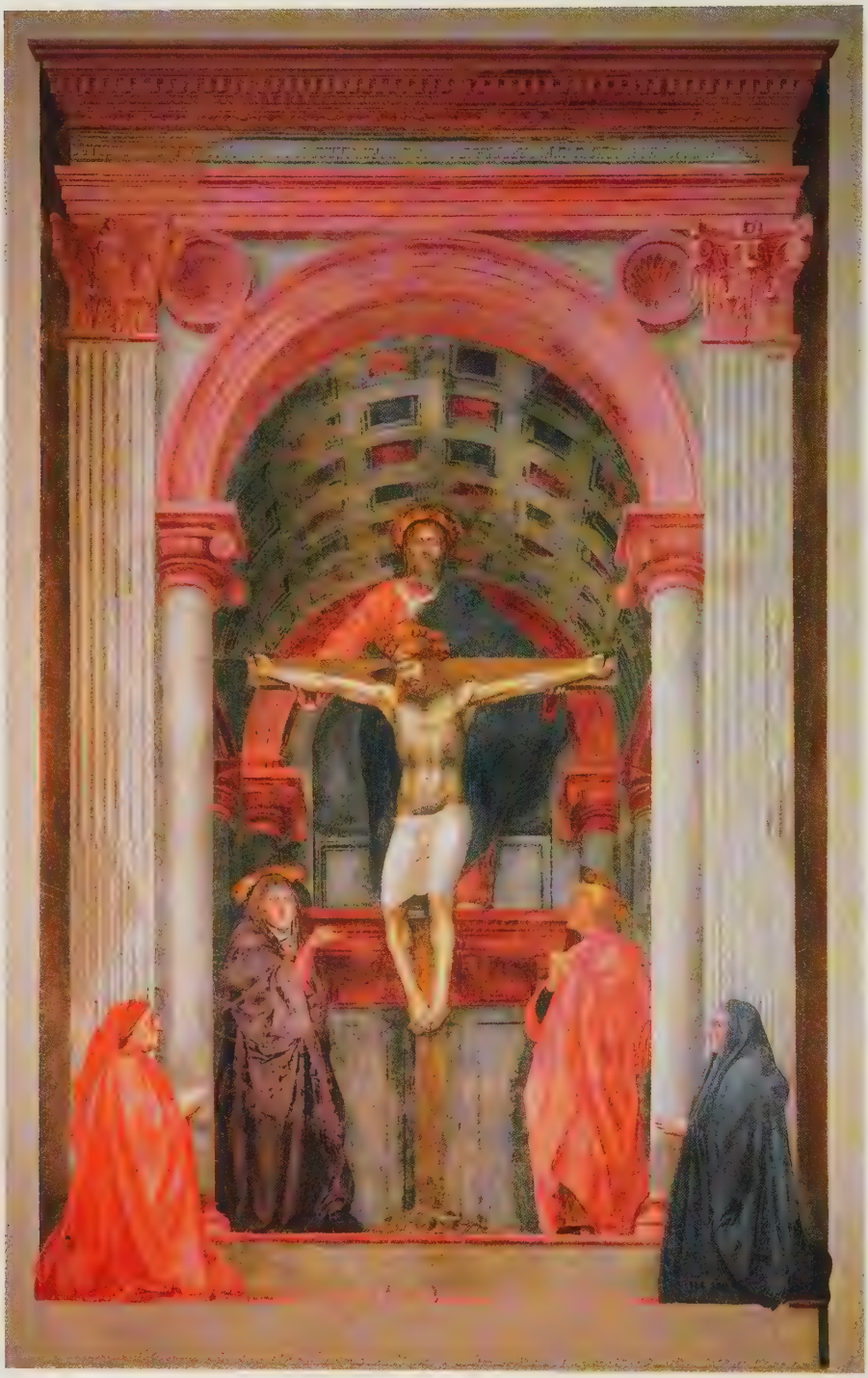


Figure 65: Masaccio, The Holy Trinity with trompe l'oeil chapel, Santa Maria Novella, Florence, ca. 1438 (Bridgeman Art Library).

tive related to our bodies is distinct from a mathematical perspective applied in the service of an abstract schema. As Norman Bryson has shown, the two systems are blended in the face of the Virgin.[35] This makes sense, for Mary belongs to two different places. She was present at the historical Crucifixion and at the same time appears to us at the site of the picture, in Florence. The more the painted chapel seems to be a contemporary chapel, the less possible it is for the Crucifixion to be taking place there. We see a chapel where there is none, and we see a crucifixion that can take place neither on this site nor in our presence. A twofold gaze is required for the painting to work. Perspective appeals to the viewer's empathy here, but a painted skeleton startles the all-too-optimistic gaze and challenges the viewer's presence at the site. This dead doppelgänger reminds him that his gaze, the value of which perspective had so optimistically increased, is mortal after all.

The interplay between painting and architecture in Masaccio's fresco had a surprising sequel in architecture that has been neglected by art historians, namely the Cardini Chapel in the church of San Francesco in Pescia (Fig. 66). Its construction is reminiscent of Masaccio's far more famous work.[36] Brunelleschi's son-in-law had a hand in it, even though we know today that the chapel was built during Brunelleschi's lifetime. Berto Cardini was not buried in the chapel until 1451, however, and it was at this time that his sons commissioned the fresco with his epitaph (Fig. 67). The crucifix was also painted then by Nero di Bicci, and there can be no doubt that the chapel Masaccio painted in Florence, which is also dedicated to the Trinity, served as a model. Yet the work in Pescia is not just a copy, for the architectural forms reflect a free use of Brunelleschi's repertoire.

We are concerned here solely with the perspective, which in this case is constructed and not painted. The altar at the entrance to the chapel keeps us at a perspective distance from the interior, which presents itself as a "picture" of a different kind. Once again we cannot enter the space—but for different reasons. It has been designed as a visual image that demands a particular standpoint for the viewer. In Pescia the lines of sight run differently because this time the chapel opens at the viewer's level. The adjoining rooms repeat the "rooms" on both edges of the fresco, permitting access to the tomb from the side; we do not need to use the main entrance, the place that shows the construction in proper perspective. The crucifix, which is part of the manifestation of the Trinity in Florence, has been moved away from the wall into the interior of the chapel. In both sites the main idea behind the project is the scenography, that is, to create a "room" in a picture or to turn an actual room into a picture. It produces a chapel prospect that gives the impression of a stage, a stage for our gaze.

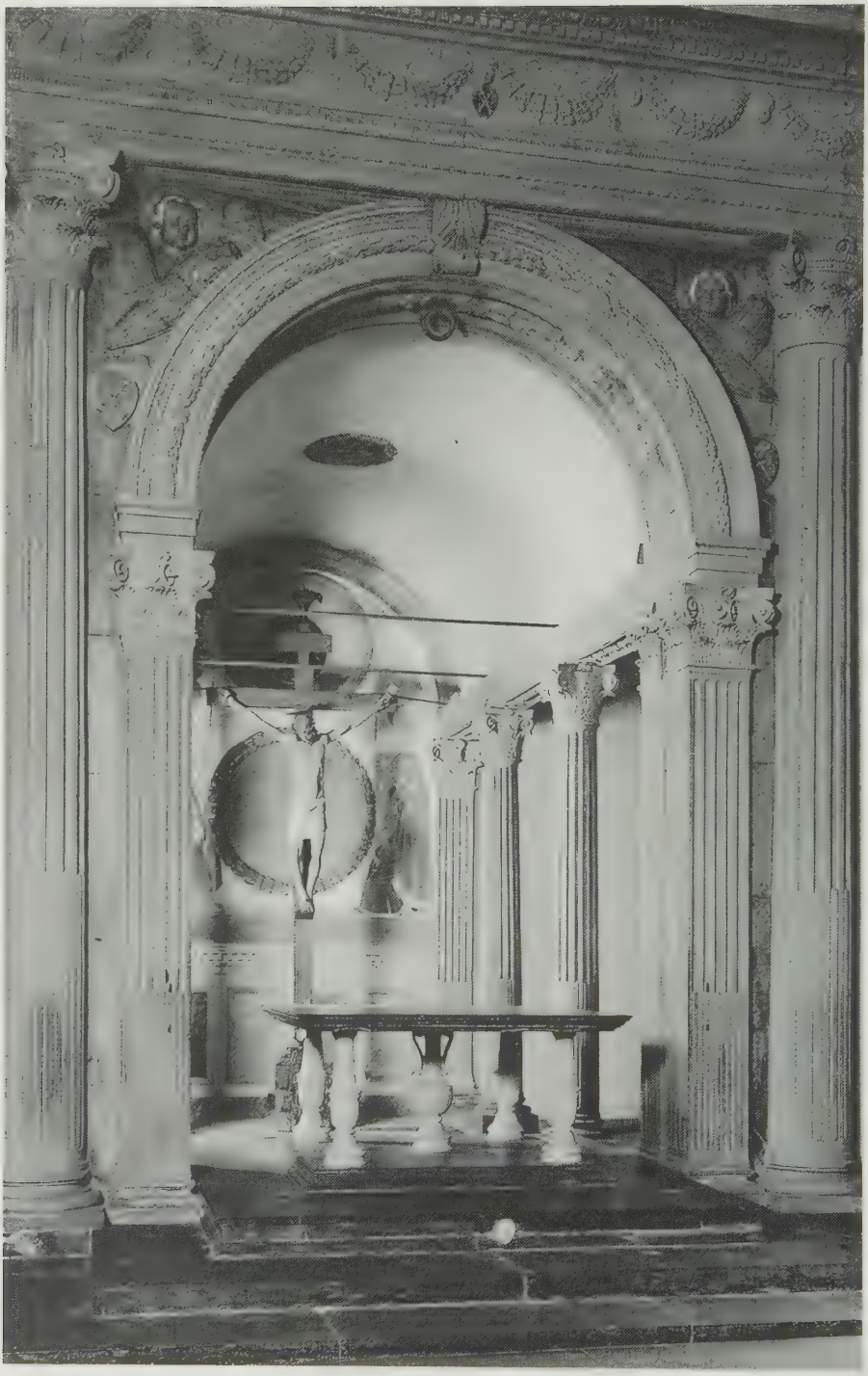


Figure 66: Cardini Chapel with a replica of Masaacio's fresco, San Francesco, Pescia, ca. 1440 and 1451 (Aurelio Amendola).

A very different example of early perspective painting, almost the opposite extreme from Masaccio's fresco, can be found in Piero della Francesca's *Flagellation of Christ,* in Urbino, thought to date from between 1460 and 1465 (Fig. 68).[37] The calculations used in constructing it have already been discussed (see p. 155). While the fresco in Florence is several times larger than the normal perspective "window," Piero has gone to the other end of the spectrum in his intimate cabinet piece. Its contents have become an open question again since it was discovered that the famous work did not arrive in Urbino during the lifetime of Federico da Montefeltro, who was previously thought to have commissioned it. There has been a further discovery, too, that calls for a renewed discussion of its subject matter. Among the three people in the foreground, the young man in the middle depicts Duke Oddantonio, who was already dead when the picture was painted. He was succeeded by Federico, who probably had a hand in his predecessor's murder.[38] Yet our concern here is not the subject of the painting but solely the question of why the painter separated two narratives, one biblical and one contemporary, by guiding the viewer's gaze in two ways. The architecture that divides the picture draws the eye toward a vanishing point that, although invisible, tethers the two sides together. On the right we see a prospect of a city dominated by the three contemporary figures, on the left an interior in Pontius Pilate's house, where the flagellation of Christ is taking place. There the architectural elements correspond correctly to the norms of antiquity, as if we were in a different era. The two narrative scenes, one a real city and one a room from the painter's imagination, are so different that it takes a special perspective to place them in our field of vision simultaneously. We see two places and two eras, the present and antiquity, although the unity of place and time was otherwise a foundational principle of the new perspective technique. Using this twofold stage,

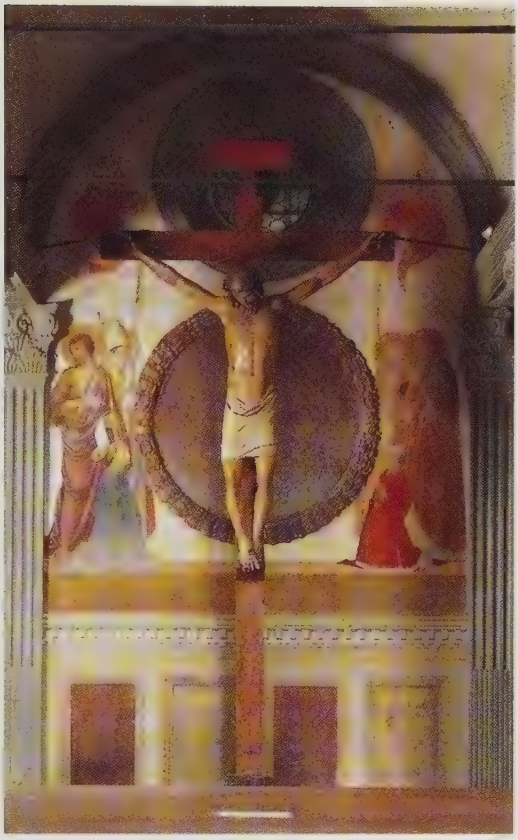


Figure 67: Cardini Chapel with a painted crucifix by Nero di Bicci, San Francesco, Pescia, 1451 (Aurelio Amendola).

Figure 68: Piero della Francesca, Flagellation of Christ, thought to date from 1460 to 1465, Galleria Nazionale, Urbino (Alinari / Art Resource, New York).

Piero created a complex and coded meaning that many interpreters have tried to resolve, without success.

The relation between the interior of the palace in Jerusalem and the exterior view of an Italian city is such that a kind of window in the picture opens on the left; the two settings appear at different distances to our eye. The receding edges of the interior architecture lead to the main scene in the background and force the gaze to travel a longer path. Alberti's painted "window" has become two (like a contemporary computer screen with two windows opened), a circumstance that may contain an allusion to our binocular vision. Perspective becomes a process of pictorial narrative in the sense of Alberti's *historia*—and the demands placed on it here are perhaps too great. Piero has taken what is formally constructed as a single view and employed it for a production on two stages. There is a mathematical perspective based on the architecture and a narrative perspective that tells and simultaneously encrypts a story with two strands; together the two give rise to an ambivalent irritation/fascination. Piero, who was mathematically talented, may

have attempted something that became standard only later in mannerism and the baroque period, namely to tell a story with two voices in one picture. We are pulled into the picture and also meet with a symbolic choice between two gazes. Piero's painting, which is so small in format that a connoisseur could easily have held it in his hands, is a kind of "magic lantern" from the early Renaissance. It should be noted at once that in the baroque, magic lanterns were used, like Piero's painting, as an intimate theater for the gaze in private, while theaters served it in public.[39]

"Prospects" on the Stage

Theatrical performance, which has a fundamental connection with seeing, occupied a central place in the visual culture of the early modern period. In this context the new perspective image as a cultural technique came to dominate the backdrops designed for the stage.[40] This holds true particularly for what is called the "perspective stage," although it has received little attention from art historians and remains the domain of specialists in the history of the theater. A possible explanation is that early backdrops were ephemeral; they have tended not to survive and are known mostly from descriptions and sketches. Yet textbooks on perspective, such as those by Serlio and Vignola that we have already encountered (see pp. 22–23), devoted a considerable amount of space to them. Painters could develop perspective art for the stage in a pure form that existed otherwise only as an idea. We must abandon the notion that perspective should be understood solely as an objectified form of seeing and categorized as science, for it could be applied without problems only in a world of the imagination—in theatrical performance. A backdrop was an ideal format in that it had no plot, no story to tell, and was limited to a prospect of architecture.

The secular theater of the Renaissance developed a form of staging that had no equivalent in classical antiquity, and backdrops represented an even greater departure from the past. Permanent structures modeled on ancient theaters existed only from the late sixteenth century on; before then theatrical performances took place in sites that had been temporarily redecorated for the purpose. In such cases the German term *Bühnenbild* ("stage-picture") had a quite literal meaning. The actors needed a picture to show where a play was set. A backdrop typically

depicted architecture that was supposed to represent a site from antiquity and looked more or less ancient, although the design was based on the new perspective principle. In the actual setting of an aristocrat's palace, the only indication of the site of the story was a backdrop, for movable scenery (side flats) had not been invented yet. Additionally, as we shall see, a backdrop told the audience whether the play they were about to see was a tragedy or a comedy.

As two media that worked with linear perspective, painting and backdrop design were competitors. With one exception, however, backdrops were limited to architectural themes. In their performances actors made no overt references to them, although sometimes children were placed in the background to link the perspective scene to the action of the play and increase its effect.[41] During the high Renaissance, strict separation between the backdrop and the actors' space was still the rule. The "prospect" (the *scena*) consisted of a carefully calculated static image, whereas the action of the play changed from moment to moment. The theater thus afforded audiences a twofold view: first, a view of *the action* in front, and second, a view of *the perspective site* at the rear, which remained unaffected by the performance. The space used by the actors had no connection to the space depicted in the "prospect." For a long time actors performed only on a narrow proscenium adjacent to the footlights, and the entire depth of the stage was reserved for the *scena*.

The complete separation of the stage from the auditorium took place when the first permanent theaters were built and became the norm in the early modern period. The two spaces faced each other and from then on remained discrete, just as a perspective painting receded behind its frame from the observer standing in front of it. In the theater the division between "outside" (the audience) and "inside" was heightened by the "aesthetic boundary" running between them. What lay behind the curtain and footlights was a kind of three-dimensional picture, in which backdrop and actor belonged to another world that could be reached only by the gaze. The effect of the space occupied by the stage, this effect of a framed picture, becomes evident in a notable photograph taken inside the Palais Garnier, the old Paris Opéra, by Candida Höfer (Fig. 69).[42] The white fire curtain, which delineates the space of the stage more sharply than a cloth curtain would, resembles an artist's empty canvas or a cinema screen on which pictures are projected, even though we know that behind it lies a stage on which at the moment no play is being performed. All the seats in the auditorium are concentrically oriented toward this "projection screen." Such a caesura between audience and stage did not exist yet in the early days of the theater. The boundary line tended to run, rather,

between the site of the action and the backdrop, that is, within the stage itself, while the audience's spatial relation to the performance space could vary.

The perspective backdrop served as the foil for a stage that now functioned as a single unit, replacing the older kind on which several settings would share the space. In his essay on audiences and the stage, Dagobert Frey points out that in the Middle Ages the gaze shifted from one scene to the next without focusing on the stage as a whole, analogously to the conventions of medieval painting. Not until the Renaissance did the simultaneous perception of time and space on the stage become the precept for the gaze. Julius Caesar Scaliger (died 1558) mocked an outmoded performance on a stage where all the actors remained in view and

Figure 69: Fire curtain in the old Paris opera house, Palais Garnier, by Candida Höfer, 2004 (© 2011 Artists Rights Society [ARS], New York / VG Bild-Kunst, Bonn).

simply pretended they were not present if they had no lines to speak. By his time the theater had already submitted to the principle of the perspective-based unity of space, as represented in new paintings.[43] The unity of space and time was also supported by the backdrop, since it depicted only one site and was not fragmented by different sets of scenery.

Brunelleschi has been credited with inventing perspective; he was also a sought-after stage designer who revolutionized the theatrical conventions surviving from the Middle Ages. In his day church interiors were still used for presenting performances of a religious character in the medieval tradition, as the term *sacra rappresentazione* suggests. In 1422 Brunelleschi staged an enactment of the Ascension in Santa Maria del Carmine in Florence, for which he made use of the entire church. This project transformed the nave into an auditorium and the choir into a stage. From an artificial mountain Christ rose high into the dome by means of a harness-and-pulley apparatus. A circle of angels stood on an elevated stage there, and a curtain was drawn back to reveal the seventh heaven. The production was a demonstration of perspective technique, although it is doubtful that the theory of vision applied in heaven.[44]

Brunelleschi also designed a stage to represent heaven for a performance in another church in Florence, San Felice in Piazza. There he suspended a hollow hemisphere, which could be made to rotate, from the actual dome of the church.[45] Inside the bottom of the hemisphere was a ledge wide enough to stand on, where boys dressed as angels stood; harnesses, which prevented them from falling, created the impression that they were flying through the air. Francesco Botticini's painting now in the National Gallery in London (Fig. 70) appears to have been inspired by Brunelleschi's designs for these productions. This colossal work in landscape format was created between 1474 and 1476 and depicts the Assumption of the Virgin. Above a panorama of a landscape near Florence, laid out in strict perspective, the sky has opened to reveal a view of heaven as Mary is received.[46] Heaven resembles a church dome suspended above the ground like an enormous bell. The perspective compelled the artist to distort it into an ellipse and limits the view into the circular dome of an observer standing in front of the painting. The perspective schema is maintained even more pedantically in the dome, as if to demonstrate that perspective also applied to heaven. The angels and saints enact in the beyond a drama of perspective for earthly eyes.

What is known as the perspective stage was developed for the comic theaters in Venice in the early sixteenth century. It operates "with lines of sight in the structures on the stage and the vanishing point on the backdrop. *Prospettiva* or

Figure 70: Francesco Botticini, Assumption of the Virgin, 1474–1476, National Gallery, London (© National Gallery, London / Art Resource, NY).

scena means the backdrop, while the constructed scenery on the stage was usually referred to as the *apparato*."[47] Both components of the stage decoration, the three-dimensional and the painted parts, had a shared vanishing point and stood behind the actors' space on a higher level. The convincing effect of the "prospect," its deceptively genuine-seeming imitation of reality, elicited admiration from contemporaries. They mentioned the "proper view of things" and the "very successful perspective," which the artists had already practiced in their paintings.[48]

The prospects, with their views of ancient buildings, evoked the loss of a golden age and encouraged a sense of nostalgia. The stage design also impressed audiences, as we know from the account of a performance in Rome in 1531. Marco da Lodi, who attended a play by Plautus, wrote that the temples of Athens appeared to be real, even though they were only painted. At the back of the stage a street was depicted and little puppets moved back and forth along it; they were only one and a half *palmi* tall, but resembled real people seen from a distance.[49] Perspective was a "symbolic form" on the stage as well. The new "stages for the gaze" were set up indoors but depicted the world outside, in the same way that perspective paintings offered a "window" onto it. A perspective stage requires "a geomet-

rical representational model" with distances that can be measured.[50] Nevertheless the perspective did not function correctly between the audience and the actors because no fixed distance point exists in a theater. The horizon remained linked either to the auditorium or to the proscenium; hence the illusion offered by the prospect derived solely from guiding the audience's gaze to a common point. The fact that there were seats at the sides—and perhaps higher seats at the rear—destroyed the whole idea of a single viewing point in any case, yet everyone held fast to the perspective schema.

The architect Sebastiano Serlio (1475–1554) used two vanishing points and drew a second horizon on the stage so that the stage appeared to withdraw from the audience and create an "adjoining room."[51] He had studied stage design with Baldassare Peruzzi and achieved his greatest success with designs for three different genres of drama and a new interpretation of Vitruvius's rules. Tragedy *(scena tragica),* whose characters possessed power and high rank, had backdrops with views of splendid palaces and public buildings (Fig. 71). Serlio interpreted the appropriate setting for comedies, then the dominant genre for productions in the vernacular language, as urban prospects with mixed architecture, including churches, that would represent everyday life. And for satire, the third form, he recommended a pastoral setting with an open landscape and rural buildings. The eye point varied according to the genre; for example, it was placed lower for comedies to represent the view of the common people.[52]

Serlio permitted no living actors around the backdrop, only figures of wood and papier-mâché that would grow smaller toward the rear to match the lines of flight and the architecture. On the backdrop, "in a very small space," palaces and extensive temples should appear both near and far. Everything was to be arranged on the stage so that it appeared best "in the gaze of the spectator."[53] In the drama, or *Schauspiel,* as the German term so accurately calls it, the gaze—unlike the ear—was related to the image behind the stage. Serlio expresses regret that the view of a backdrop for tragedy (see Fig. 71) is not entirely successful, due to lack of space. In fact the woodcut conveys only an approximate impression of the prospect. When one compares it to a painted stage prospect from Ferrara dating from 1520 (Fig. 72), then the ambivalence between the image and the stage becomes evident.[54] In the Ferrara backdrop the double staircase lies not to the sides but in the middle of the prospect. We can see better how the floor tiles in perspective stop unexpectedly at the proscenium. The space on which the actors could walk was only a narrow strip up to the corners of the buildings. On the street leading to-

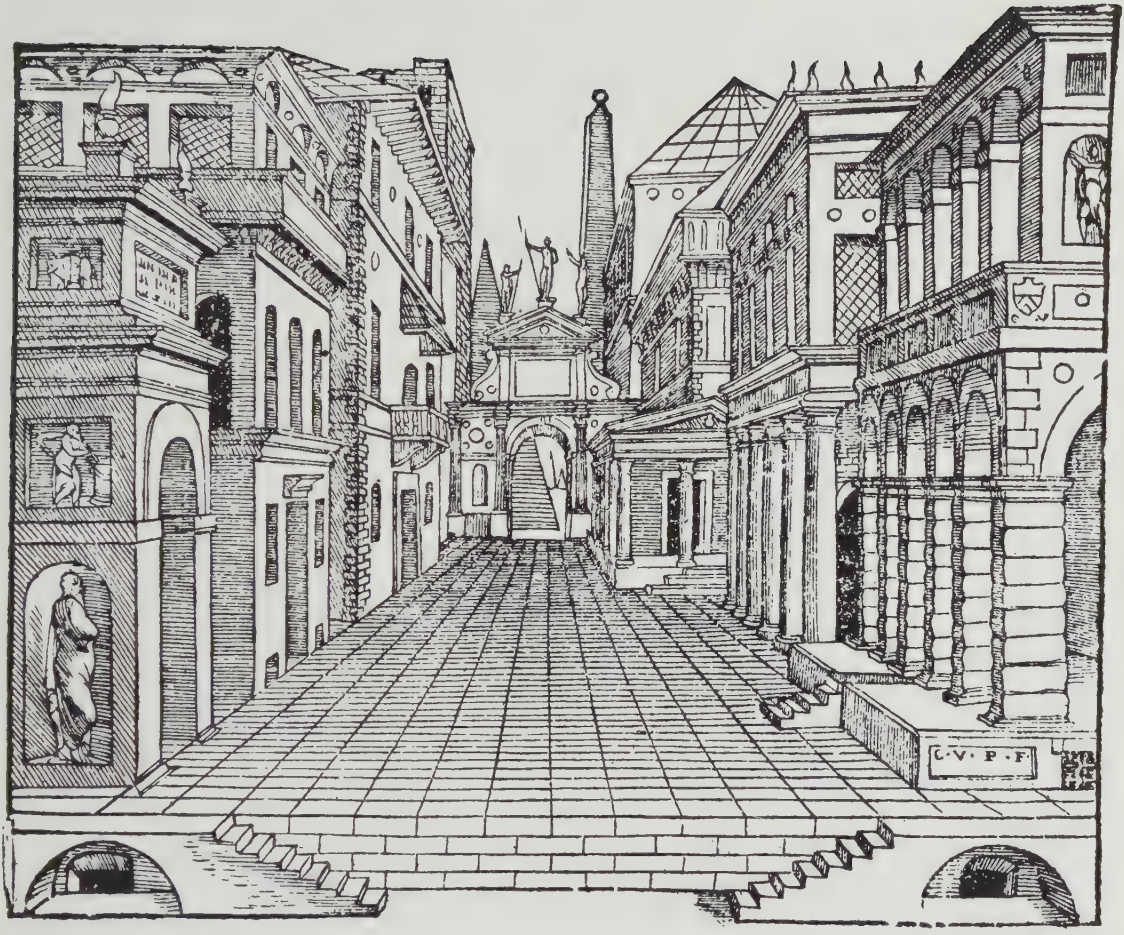


Figure 71: Sebastiano Serlio, sketch for a stage backdrop for tragedy, On Perspective, Book II (Bridgeman-Giraudon / Art Resource, New York).

ward the background, the *stage* changes into a *stage prospect* whose space was only painted.

The spatial separation between the performance space and the prospect was the result of a rigorous approach to perspective. It was also practiced by painters of prospects who introduced the same dualism of two spaces and two views in their paintings.[55] Serlio's stage views, in contrast, made their paintings legible for a theater audience.[56] The Venetian Paris Bordone provides valuable testimony on this point. In 1545, shortly after the publication of Serlio's second volume, he reproduced Serlio's "tragic scene" in the biblical story of David and Bathsheba, as an allusion to the unhappy outcome of the king's love affair (Fig. 73). The pros-

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Figure 73: Paris Bordone, Bathsheba Bathing, ca. 1545, Wallraf-Richartz Museum, Cologne (Rheinisches Bildarchiv Köln).

pect, with the view of the city in the background, contrasts with the biblical narrative in the foreground, and the foreground garden breaks off abruptly where the paving stones of the street begin. In a subtle bit of humor David, who is watching Bathsheba as she bathes, is placed in the backdrop, where there were no actors at that time. The theater prospect transforms the painting into painted theater.[57]

Figure 72: Prospect of a city street, theater back from Ferrara, 1520, collection of the Palazzo Strozzi, Florence (Photoservice Electa Mondadori / Art Resource, New York).

In England the "prospectives" of the Renaissance stage were first introduced a century later, when their vogue in Italy and France was almost over. Shakespeare, who called the stage "insubstantial" in *The Tempest,* still had little to do with the stage prospect. Ben Jonson and the architect Inigo Jones, however, quarreled over whether in masques, as some dramatic performances were called, the stage set

Figure 74: Inigo Jones, A City Square, stage backdrop, collection of the Duke of Devonshire, Chatsworth (Chatsworth Photo Library).

("the body") or the text ("the soul") should take priority. Jones was just as familiar with the new stage techniques as with the tradition of the Renaissance prospect. His view of a city square reproduces the effect of the perspective prospect better than Serlio's early woodcuts (Fig. 74). In Jonson's *Masque of Blackness* spectators saw not scenery "dispersed around the stage" but rather "one indivisible scene where the action was set." A spectator later reported how the lines of "prospective" were drawn from the horizon of a part of the sea, with "the whole work shooting downwards from the eye." The stage design "caught the eye a farre off with a wandering beauty."[58] Perspective was something entirely new in the English theater.

Lorenzo Lotto went a step backward in the stage design of his era when he designed intarsia for the choir of the basilica Santa Maria Maggiore in Bergamo in the 1520s. In the biblical story of David and Goliath he situated one scene on a stage (Fig. 75).[59] The stage shows the throne room of King Saul, where the young David is offering to fight. In front of the stage the next part of the story, the fight

Figure 75: Lorenzo Lotto, stage with a scene from the life of King David, intarsia, 1527, Santa Maria Maggiore, Bergamo (Alinari / Art Resource, New York).

between David and Goliath, is shown taking place. Despite the two exits and the stairs, the stage itself is at the same time what it represents—a room in a palace. It is not a boxlike medieval stage nor is it a new perspective stage, since it is missing a crucial feature: the perspective backdrop. The enigmatic artist is playing with ambivalence here, as he does elsewhere. Here it is the ambivalence of place, since the throne room only resembles a stage without being one. It is the place of the biblical narrative itself, even though it alludes to a stage.

The situation of the stage in the Renaissance has been at the center of our deliberations here, but it changed fundamentally in the seventeenth century. The rear of the stage ceased to be merely an image and became space that actors could use. The impression of a single homogeneous visual field gave way to the illusion of different rooms or spaces. The technicians who could simulate clouds and con-

flagrations became more important than set painters, and the invention of movable scenery made it possible to change the set during the play and not just at intermissions. Nicola Sabattini mentions how sets could be made to depict heaven or hell.[60] In the tendency to make stages less realistic one can recognize a countermovement to the "prospect" of the Renaissance. Dramatic artistry with respect to *time* replaced static artistry with respect to *space* on the stage. The perspective backdrop had become outdated when an anti-perspective campaign using the methods of perspective robbed the human subject of his specific location. One can speak of a paradigm shift that made perspective the accomplice of trompe l'oeil.

For the Jesuit fresco painter Andrea Pozzo, "deceiving the sense of vision" was his declared program. In "mixing fiction with reality," perspective became pure form, susceptible to playful variations. Pozzo worked in both theaters and churches, and his frescos in churches became their own kind of theater, where viewers could forget the real church and its space when they moved from one spot to the next. In Sant'Ignazio in Rome the eye point necessary for the illusion of an open heaven is marked by a tablet on the floor. Everywhere else the painting is exposed as an illusion.[61] Perspective lost its significance for the power of the gaze once the weakness of the sense of sight had become apparent, but even after its defeat the eye still longed for new and exciting diversions.

The *folie du voir,* in Christine Buci-Glucksmann's phrase, triumphed over reality, and as new forms of spectacle were constantly developed, the public even craved anamorphosis, the hidden perspective introduced at that time.[62] The new option consisted of escaping into a dream world, since reality was lost in the gaze and one experienced only deception. Now the theater specialized in showing that the world was mere illusion. As the setting shifts between prison and the royal palace in Calderon's comedy *Life Is a Dream* (1635), Segismundo gradually loses his identity. He can no longer distinguish between illusion and reality because he can't tell when he is awake and when he is dreaming. In his description, "Life is a dream, from which only death awakens us." "What is life?" he asks. "A vain hope, a shadow, a fiction" (lines 2260–2290).

Conservative critics who enthused about the political theater of classical antiquity feared that the truthfulness of plays was threatened by the lies of the scenery. François Hédelin, abbé d'Aubignac, for example, argued in his *Pratique du théâtre* (1657) that the freedom of stage designers and actors to create illusions ought to be limited. The sets might be "fictions" and pleasing to the eye, he said, but they should not contain obvious lies. Naturally "deception" was an essential task of the

theater and its "ingenious magic," and comedies could be performed so that spectators forgot they were watching a play. With tragedy, however, the relationship between "representation and truth" had to be maintained. Aubignac suggested a comparison with a painting, which can be viewed "in two ways." First of all, it creates an effect as a work of art through its colors and evokes a "world of appearances," but one can also look at its content, namely "its order and reason." Similarly, a drama is on the one hand merely playacting and performance in which actors present "images of things that do not actually exist," but on the other, it tells a story "like an actual event."[63]

The court theater of the baroque—with its loges and the privileges or constraints of the social order—had its real location in the gaze of the sovereign, and the illusion on the stage was linked to the royal box.[64] The perspective principle had become absolutist in nature, for it was subjected to the gaze of the absolute ruler and fed his illusion that he could survey his realm as completely as he could a theater. During the Enlightenment some critics opposed this principle, hoping to democratize the theater instead. This was the intention behind Claude-Nicolas Ledoux's design for a theater in Besançon in 1779.[65] "One of the great advantages of the theater," he observes in his textbook on architecture, "consists of seeing all around and being seen." The natural order of society would be restored when every member of an audience there had "won the right to see in the same way" as every other. Then the people would represent themselves instead of having one person oversee all the rest, and perspective space would be orchestrated anew on a collective level.

All the same, Ledoux's work contains a hint of what would happen to the space of the collective gaze. An illustration of his, entitled *Coup d'œil,* which may not have been added to his book until after the French Revolution, shows an eye large enough for a whole theater to fit inside (Fig. 76). Nothing in the space over which this eye exercises its authority can remain hidden. From the stage a beam of light, reflected in the eye, plays over the auditorium. The straight visual ray, the shortest connection between eye and object, here serves the purpose of "supervision" that is mentioned in the text. Control of visual space has become anonymous. Michel Foucault found this a useful example when he introduced a new term for the modern mass gaze, "panopticism." The technique of control that makes everything visible while remaining invisible itself is a gaze without a face that keeps the entire society under surveillance.[66] The theater loses its special position in the public space. The stage no longer lies at the end of the public's gaze, in Ledoux's vision; instead one could say it is looking back at its audience.

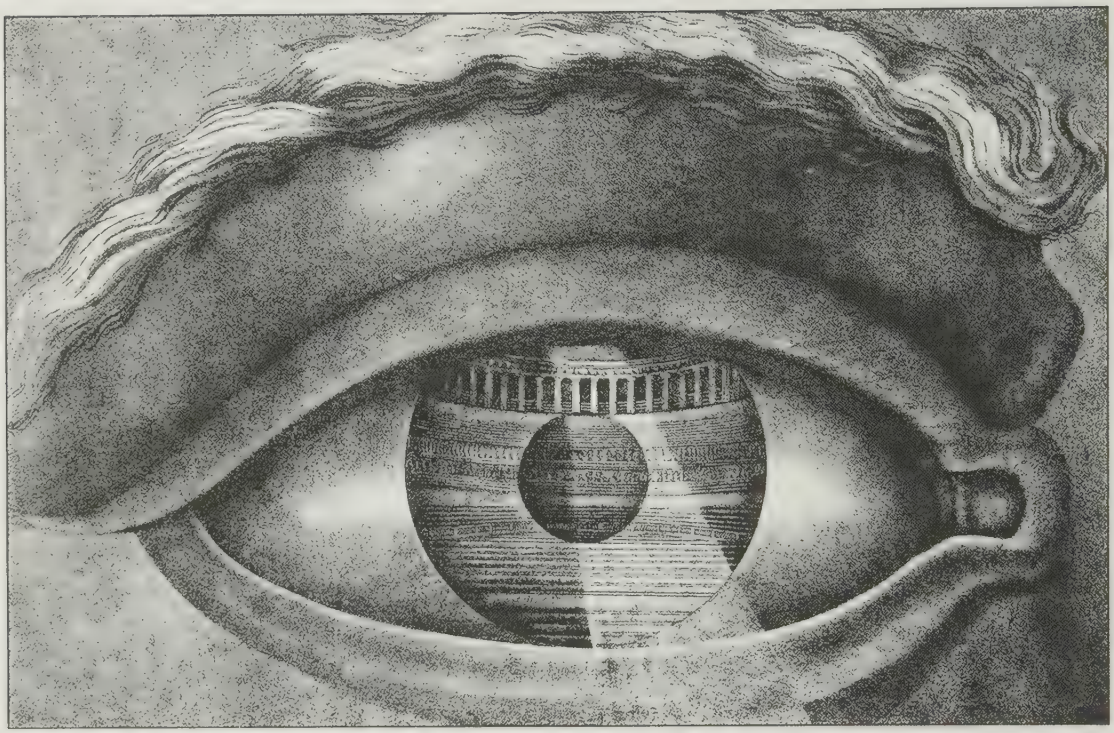


Figure 76: Claude Nicolas Ledoux, eye with theater auditorium, from L'Architecture considerée sous le rapport de l'art, des mœurs et de la legislation, 1804 (Réunion des Musées Nationaux / Art Resource, New York).

Panoramas in Urbino

The pictures that Alberti used to demonstrate perspective (see p. 171) have not survived. The famous panoramas from Urbino, showing deserted cities, have been convincingly connected with his name, however. They bear a strong resemblance to stage backdrops even though they date from an earlier period, before backdrops are known to have been used in theaters. The three panel paintings, dating from about 1470, are not signed, nor do they depict actual cities; instead they are meant to demonstrate the perspective gaze in a pure and idealized form (Fig. 77). Where human beings appear in them, crossing one of the city squares, they appear to be the size of ants, and behind them the buildings no longer correspond to any real scale. The idea for these works—now in museums in Urbino, Baltimore, and Berlin—appears to have originated in the small principality of Urbino; the only one of the pictures with a full provenance comes from there.[67]

Figure 77:
Three panoramas of ideal cities, from Urbino ca. 1470; now in the Galleria Nazionale, Urbino (top); Walters Art Gallery, Baltimore (middle); State Museums, Berlin (bottom) (Bridgeman Art Library; Bildarchiv Preussischer Kulturbesitz / Art Resource, New York).

Figure 78: Panorama of a city, from Urbino ca. 1470, resembling a stage without an apron, State Museums, Berlin (Bildarchiv Preussischer Kulturbesitz / Art Resource, New York).

No play is being performed here; rather, the stage itself has become the theme, as in the now-familiar 3-D computer animations that can be stopped with a click. Here it is our own gaze that is being staged. Perhaps these panoramas were conceived with the theater in mind. Such radical perspective can be carried out only with architecture, since the everyday world of human bodies in motion cannot be measured in the same way. It is paradoxical that perspective artists, of all people, abandoned empirical visual experience for a geometric world and left the moving eye behind.[68] The concept of a utopia, which did not yet exist at that time, refers to an idea that "has no place" in the real world. The world of perspective is in principle a utopian world that sublimates the gaze to an ideal.

All three panels create an impression of complete coherence in which every-

thing is centralized for an individual gaze—at least on the surface. The construction sketch for each one was incised on the undercoat according to the same principle, before the actual painting began. The Berlin panorama has even more of the character of a stage than the others because of its proscenium (Fig. 78). The empty center draws our gaze toward a vanishing point that lies on the surface of a sea behind the city, where a ship appears to be sailing straight toward this imaginary spot (see also Fig. 99). In the Baltimore panel the vanishing point lies in the infinite distance behind a triumphal arch (Fig. 79). This work contains a reference to the Baptistery in Florence, where Brunelleschi demonstrated his perspective paintings. Across from that building there appears, like a quotation, the reconstructed Roman Colosseum next to modern Renaissance structures. Finally,

Figure 79: Panorama of a city, from Urbino ca. 1470, Walters Art Gallery, Baltimore (Bridgeman Art Library).

in the painting now in Urbino an ancient round temple stands at the exaction location prescribed by Vitruvius. The world of antiquity takes on the character of a constructed model on the painted stage. The three views, which each depict a different city in the same manner, like a stage backdrop, were obviously variations of a single project.

It is apparent that we are not dealing with the usual kind of painting here, first since these city views contain no action and no reference to a familiar narrative, and second because they were not signed by an artist to who wished to establish himself as their creator. But what were they? The provenance of the painting now in Urbino can be traced back to the court of Federico da Montefeltro, and a second painting of this kind is mentioned in an early inventory, where it was described as hanging above a doorway in the duke's chamber.[69] In the year 1465 the aged high priest of perspective, Paolo Uccello of Florence, was invited to settle in Urbino.[70] A few years later, in 1469, Piero della Francesca's presence is documented in Urbino, where he presented a copy of his treatise on perspective to the ruler.[71] The masterpieces that he created for Federico prove beyond all doubt a close connection with the duke; they include the portrait of Federico and his

duchess that hangs in the Uffizi Gallery and the great altarpiece now in the Brera Art Gallery in Milan.

Lastly, the architect Leon Battista Alberti was courted as an architect again and again once the duke had started building his palace in Urbino. We know from Cristoforo Landino that Duke Federico and Alberti engaged in confidential talks. In a recent study Alberti was correctly suggested as being the moving spirit behind the paintings, even if they were not all carried out before his death in 1472.[72] A perspective utopia is expressed here in pictures demonstrating architectural monuments. Anthony Grafton distinguishes between Alberti the utopian and Alberti the empiricist who participated in building Pienza, planned as an ideal city by Pope Pius II.[73] In his *On the Art of Building in Ten Books,* Alberti made the idea of founding a city his theme. His descriptions are cityscapes in words rather than pictures and contain a whole catalogue of different building types. His overall scheme assigns to each type a fixed position that relates it to the other buildings. Book seven culminates in a discussion of temples; in book eight the author proceeds from theaters directly to the topic of backdrops, which he says should illustrate each genre of drama in the same way that a city should visibly reflect society.[74]

The cityscapes also had a local significance for Urbino. Their utopian appearance points us to the gigantic project that Federico undertook in 1466 to build himself a new residence. The scale of the construction program betrays the duke's determination to think in terms beyond the *real place,* Urbino, and realize a *fantasy* in the little mountain town. The tension between reality and idea becomes evident in the contrast between the side of the duke's palace facing the town and the side facing the valley; while the town side is relatively closed, the facade overlooking the valley has two magnificent loggias designed by Lucio Laurana. On these balconies the ruler could forget the narrow confines of the walled town and dream of an ideal city. For this reason it is appealing to think of the painted city panoramas as "fictitious windows," as Andreas Tönnesmann has suggested.[75] The rich intarsia work on the doors in the palace creates "windows" of the same kind, which resemble the painted panoramas down to the details. Every time the master of the house went to open a door his gaze would encounter a make-believe world ruled by his imagination. The painted cityscapes must have given him the feeling that, using the ideas of Vitruvius and Alberti, he could build whole towns as they had not existed since antiquity. In them he could depart from the circumscribed radius of his own plans and exchange them for a dream that would never become a reality.

In these utopian designs the word "perspective" carries a particularly relevant meaning: We still speak today of "perspectives" when we make plans. The cityscapes from Urbino are models, in a manner of speaking, for a project still in the design stage for Federico and his associates. They borrow from classical antiquity to present a view of an ideal world, in which the idea of perspective as such is produced as if on a stage. Thus each of them shows a different prospect, although always in the same way. In that era the idea of an imaginary or ideal city was on everyone's lips, including the one to which the architectural theorist Filarete gave the name "Sforzinda." Filarete went so far as to claim that the first stone had been laid for his fictional city in April 1460, when he was still writing his treatise on architecture. Sforzinda has an octagonal shape with radial streets, and the author illustrates his work with ground plans and elevations.[76]

Figure 80: Design from a roll of architectural drawings, Iran, ca. 1500, Topkapi Palace Museum, Istanbul (after Gülru Necipoğlu, The Topkapi Scroll, Getty Center for the History of Art and the Humanities, 1995 / MS H. 1956, Nr. 5).

Nevertheless in the three cityscapes we are not dealing simply with views of an ideal city, for in that case they would not differ so much from one another. We come closer to the idea that they represent when we imagine them as experimental arrangements: they illustrate a view and test the perspective in a way that can be calculated easily, without the extraneous elements of narrative and human figures. It is not the ruler who is the main actor on these empty stages but rather his gaze. The gaze seems so concentrated on itself that the buildings appear almost abstract when one looks at them separately. The cityscapes are a project that could have been commissioned only by a ruler like Federico—one who was extravagant and frustrated at the same time. They offer an equation of gaze and picture in which the constructed space and the visual space overlap. The perspective system was executed here so perfectly that it could serve as demonstrational material for the duke and his courtiers, and as an inspiration for their learned debates.

Blickwechsel: The Geometry of the *Muqarnas*

For a shift of focus between perspective and Islamic geometry there is no more suitable subject than the architectural feature known as the *muqarnas,* which has drawn mathematicians' attention as much as perspective did in the West. It offered to Islamic architecture a highly visible form in which to elaborate on the omnipresent geometric patterns—the site par excellence in which to demonstrate imaginative designs. It is not easy to explain what a *muqarnas* is in Western terms;

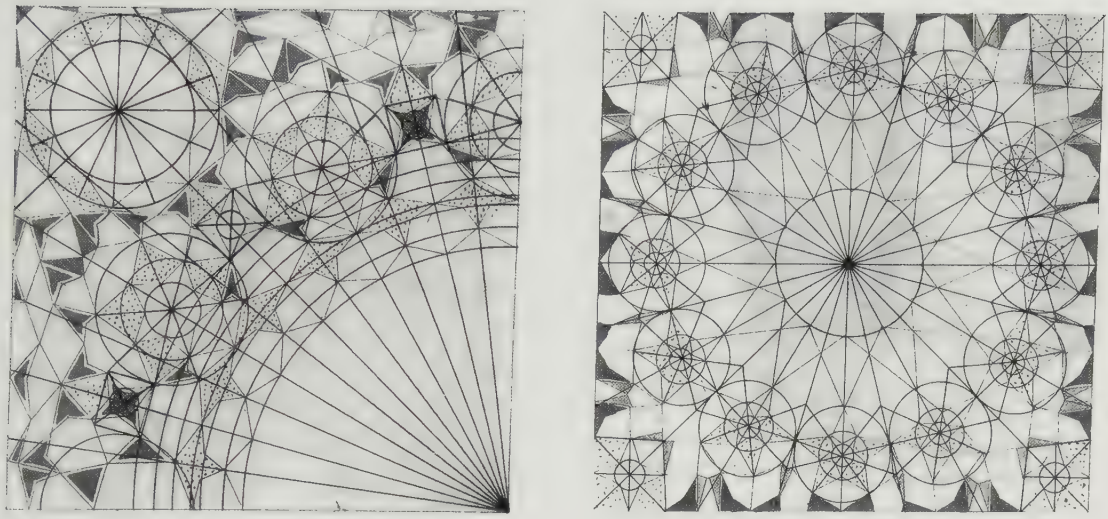


Figure 81: Design from a roll of architectural drawings, Iran ca. 1500, Topkapi Palace Museum, Istanbul (after Gülru Necipoğlu, The Topkapi Scroll, Getty Center for the History of Art and the Humanities, 1995 / MS H. 1956, Nr. 22).

in fact it's almost easier to explain *what it is not:* It is not simply a form of vaulted ceiling, since a *muqarnas* also appears as a niche on the exterior of buildings, nor is it merely surface decoration—and yet it is both at the same time. It occurs in two dimensions only in pattern books, for it was conceived to be translated into an infinite variety of three-dimensional forms over which light could play. Since the *muqarnas* serves no specific practical purpose it is a prime candidate for a "symbolic form" in Islamic culture, although that term has not yet entered the scholarly discussions.[77]

Muqarnas forms have been in use since the eleventh century and hence go back, like the calligraphy reform and the "knot style," to the lifetime of the great mathematician Alhazen. Their use reached a peak in the fifteenth century, when Florence was discovering perspective, and motivated mathematicians to seek modules that had not yet been tried. But what are *muqarnas* forms? As a form of architectural ornament they can be compared with honeycombs or stalactites. Their prismlike elements may jut out like corbels from a dome or appear stacked in tiers in the niches of a facade. Al-Kashi (died 1429), a mathematician at the court in Samarkand, described a *muqarnas* as "like a staircase with facets" that intersect "at a right angle, or half a right angle, or their sum, or another combination of these two."[78] They acquired their importance because the geometry acted as a bracket "between ornamentation and space. A building had to look geometrical."[79] This was more likely to succeed when architects dared to seek original solutions for *muqarnas* forms. They were built up in layers, so that their appearance

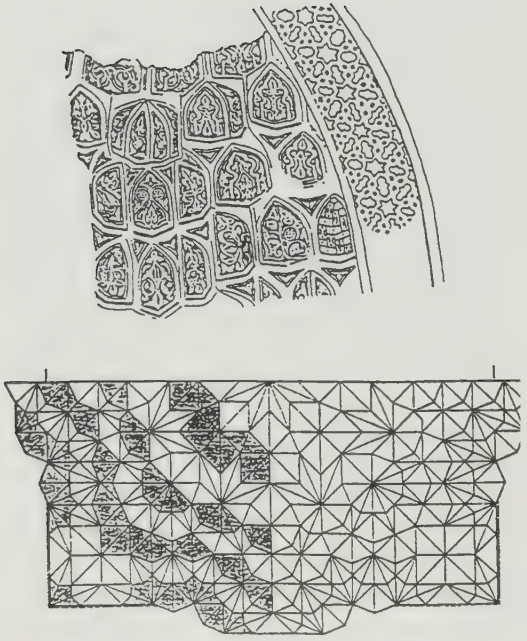


Figure 82: Muqarnas designs (after Yvonne Dold-Samplonius, "Calculating Surface Areas in Islamic Architecture," in The Enterprise of Science in Islam, ed. J.-P. Hogendijk and A. I. Sabra, MIT Press, 2003; courtesy of Yvonne Dold-Samplonius).

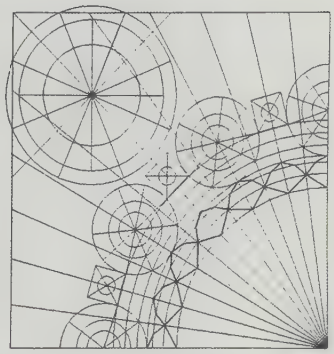
changed constantly with the angle of the sunlight that reached them. Since the elements of a *muqarnas* are not enclosed in themselves, neither logic nor mathematics imposed any limitations of scale or configuration.

The *muqarnas* was an ingenious and virtually unique architectural invention, designed to release geometry from its two-dimensional limits and take it into the places where we automatically want to speak of space with depth. Light plays as great a role here as in Alhazen's theory of optics (see p. 103). It is not related to our gaze but goes its own way. In addition, the laws of the geometry are not those that govern vision and gazing but the laws of division, addition, and multiplication. The mathematician José M. Montesinos speaks of "tessellation" or mosaiclike fields with axes of rotation that he also calls axes of reflection. Symmetries arise here with points of reflection that are often intentionally concealed.[80] Some patterns are folded along an axis, so to speak, thereby forming new axes. Whereas there are only 17 variants for rotation and symmetry on a surface, more than 200 are possible in the third dimension. Here is where *muqarnas* forms became significant; they project into space and are made up of tiny cells that refract or deflect light when it enters a room. Their surfaces interact in their spherical form and in their angles with the pathways of light.

Our knowledge about the design of the *muqarnas* has grown since a surprising discovery was made in Istanbul, in the library of the Topkapi Museum, which was once the sultan's palace. There Gülru Necipoğlu, the well-known scholar of Islam, found a scroll ninety-seven feet long, containing 114 architectural designs, most of which are for *muqarnas* forms (see Fig. 45).[81] The sketches, first incised and then traced in ink by the same hand with a reed pen, date from about 1500 and originated in an Iranian milieu. Their wealth of geometric imagination, which is not concerned with the structure they may eventually adorn, offers a stark and striking contrast to the sketches showing how to construct an image in textbooks on perspective. Whereas Necipoğlu was looking for parallels with the medieval architectural drawings of the West, we must keep in mind in our con-

text that the designs on the scroll are structurally the antithesis of the kind of spatial thinking used in perspective and its relation to the gaze. They are opposites on the same level, an opposition in which different worldviews find expression. Just as perspective was a symbolic form, so too were *muqarnas* in another culture, a culture with different priorities.

In Islamic culture, geometry had a universal validity that allowed it to cross the boundaries between architecture, decorative arts, and calligraphy. It was not just of concern to artisans but also represented the knowledge of the elite, for as the aesthetic and spiritual creed of this culture it belonged to a general education—all the more so as it occupied the place that pictures have in other cultures. As early as the eleventh century a historian reported that a ruler designed buildings "with his own knowledge of geometry, and drew the lines with his own exalted hand."[82] This probably involved much more than just ground plans, and so it is hardly surprising that mathematicians also were interested in converting equations of different grades into geometric patterns that illustrate a mathematical theorem but in a puzzling way. Al-Kashi, whom we have already mentioned, distinguished four types of *muqarnas* forms, among which the fourth, known as the Shirazi type, exceeded all the others in complexity. There radial and polygonal patterns predominate, often enriched with curvilinear forms.



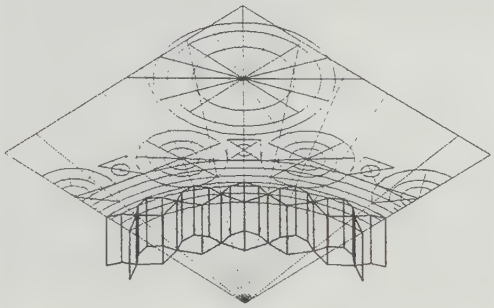


Figure 83: Muqarnas designs from a scroll, Iran, ca. 1500, Topkapi Palace Museum, Istanbul (after Mohammed al-Asad, "On the Geometry of the Muqarnas," in Necipoğlu, The Topkapi Scroll, Getty Center for the History of Art and the Humanities, 1995).

In the drawings of the Topkapi scroll a *muqarnas* is often represented in only a quarter view, but any architect or craftsman could easily have converted it into a full view. No matter how complicated they were, the patterns mirrored each other along the two main axes (Fig. 80). Other drawings show a fan-shaped ceiling vault as a whole (Fig. 81). The third dimension, whether expressed in terms of a projecting body or an empty space, was not completely fixed in the design but determined by the artisan who executed it. A pattern was conceived first of all on a flat surface, since it was demonstrated in a sketch (Fig. 82).[83] The method of convert-

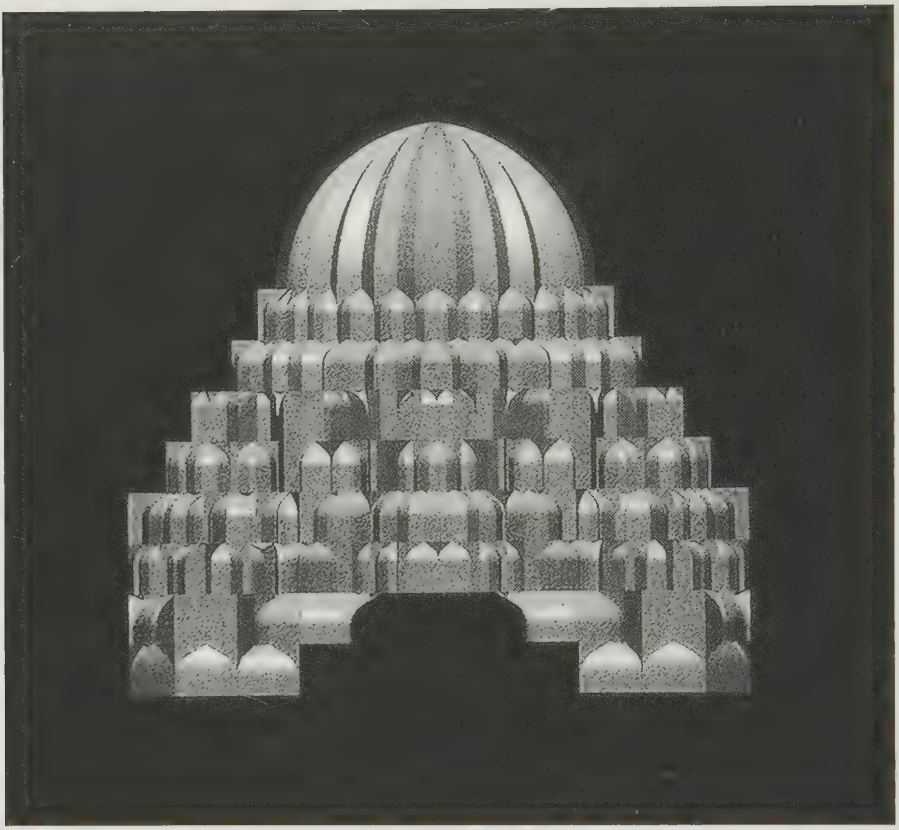


Figure 84: Computer model of a muqarnas (after al-Asad, "On the Geometry of the Muqarnas," in Necipoğlu, The Topkapi Scroll, Getty Center for the History of Art and the Humanities, 1995).

ing a two-dimensional pattern to the form of a vault (which is itself composed of flat segments) remained a closely guarded secret of artisanal workshops, however. Today a computer can be used to develop a stereometric view in which elements project from the surface in tiers (Fig. 83). A 3-D simulation is also possible with such a method (Fig. 84). Yet such attempts remain speculative to a certain degree, as Mohammad al-Asad observes, because they do not reliably reflect the historical practice for converting a drawing into three dimensions.[84]

Figure 85: Drawing for a stellate full vault from a scroll, Iran, ca. 1500, Topkapi Palace Museum, Istanbul (after Necipoğlu, The Topkapi Scroll, Getty Center for the History of Art and the Humanities, 1995).

Since the patterns were developed out of an internal order and were not related to an external viewer standing vertically in front of them, they could be located at any desired height and at any desired angle. Their geometry was calculated only in relation to itself, making it the opposite of a calculation of how to depict the world in a representational manner for a viewer. The belief in a cosmic order, which also predominates in Alhazen's theory of light, sought cognitively to go beyond sensory perception. "Geometric analysis requires dissecting the *muqarnas*

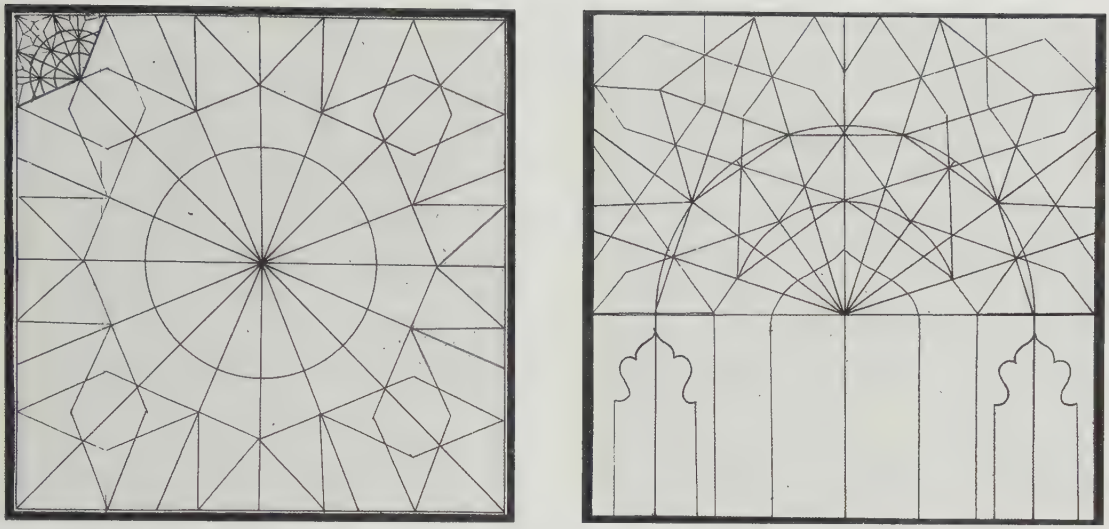


Figure 86: Elevation drawing of a facade with a semicircular vault in a niche, from a scroll, Iran, ca. 1500, Topkapi Palace Museum, Istanbul (after Necipoğlu, The Topkapi Scroll, Getty Center for the History of Art and the Humanities, 1995).

into its component parts, that is, tiers and units. One must shift to a different level of perception, one in which the gestalt is ignored and the individual unit becomes the primary focus of attention."[85]

The geometric figures (to use Alhazen's term, see p. 109) take shape along radially oriented lines (rays) that are deflected at different angles, as Alhazen assumed for the pathways along which light travels. Light forms its own patterns on them. When people looked up at ceiling vaults, the *muqarnas* forms here projected downward but had been previously calculated on a two-dimensional surface. Surface and space are here organized by the same lines, in order to allow a complex pattern to unfold in succession. The point is not whether *muquarnas* forms were based on a theory of vision, but rather that an analogy is hidden in the fact that a shared imaginative world both inspired the mathematical theory and gave meaning to the geometrical experiments of the *muqarnas*. In Alhazen's work a complex geometrical form like a *muqarnas* served as an example of how to locate imagination and knowledge in human perception (see p. 112).

Other drawings found in the Topkapi scroll contain the principle of infinitely continued rotation and symmetry. Whether it is the view of a star-shaped vault or the elevation of a façade with a semicircular vault in a niche, the principle is the same (Figs. 85 and 86).[86] At the outer edges of the vault triangles and other polygons are broken up along the radial lines that structure the entire field. Their form indicates that they were intended to project outward stereometrically from the surface of the vault. Only in one corner does the draftsman indicate that the

empty fields would have been filled in with a fan-shaped micropattern covering the surface like a lattice. In the other instance (see Fig. 86) the facade with the three doors or fields is shown in the same plane as the niche vault, which is subdivided by the same lines. The view and the projection coincide here; in terms of geometry, the wall and vault represent a single problem to be solved.

Muqarnas forms appear in a new light if we view them from the Western position of plane perspective. The elimination of an eye point, a prerequisite for pictures in perspective, opens up an infinite variety of solutions that extend across the boundary between three-dimensional space and the two-dimensional surface. Such forms contain no picture that is tied to an observer, nor do they assign a location to his subjective gaze. Their surface patterns do not contradict three-dimensional space, since the understanding of space here is a different one. Instead *muqarnas* forms occupy the threshold between space and surfaces, dividing them into various layers or steps. Surfaces become permeable, admitting space without limiting it. Visual rays, the leitmotif of plane perspective, are lacking in *muqarnas,* because they take in rays of light, which are subject to different laws. Plane perspective, in which three dimensions are projected to make a two-dimensional image, follows the principle of spatial vision and requires us to ignore the surface and "see through" it. In Islamic culture the surface is preserved; it even acquires greater value as the site of computation and perception, becoming in a manner of speaking almost sacred. When it takes the form of a window lattice *(mashrabiyya),* a surface pattern made of light, it is reflected on the floor and walls of a room. In the *muqarnas,* geometry becomes a symbolic form, just as perspective in painting did in the West.

6

The Subject in the Picture

Perspective as a Symbolic Form

Stealing an Emblem: The Eye as Representative of the Gaze

Perspective as a symbolic form does not have the same meaning here as the one Erwin Panofsky assigned to it (see p. 15). Ernst Cassirer, who first coined the term "symbolic form," did not talk about perspective; he understood it to refer to *art* in general, just as he identified *language, myth,* and *science* as symbolic forms. If we choose to follow Cassirer rather than Panofsky, we can take "symbolic form" to mean that art became a symbol for the culture of the Renaissance when it adopted perspective. The radically new kind of picture simulated a three-dimensional space that viewers then appropriated for themselves with their gaze. The analogy between this space and the human visual field was assumed to be correct, but in the last analysis it could not be proved. All the same, it was the premise for converting a *visual theory* into a *pictorial theory.* The new perspective brings the observing subject into the picture by bringing his gaze into it. The subject in this sense does not have to appear as the picture's subject in the other sense, as the person portrayed (although it is no accident that the individual portrait was invented at the same time). Rather, the subject is already present whenever a painting depicts a gaze, one that the viewer takes to be his own gaze. The gazing subject occupies a position in that he takes possession of the world as a picture.

In the Renaissance an isolated eye did not refer to the sensory organ as such; it was an emblem that "detached" the gaze from a body that was doing the gazing. The eye represents a person gazing and indicates this activity. But who is doing the gazing or is permitted to gaze like this? The gaze that surveys the world from a dominant and superior position had once been the exclusive privilege of God, the all-seeing One who has no body. Human beings do not see God but only feel that His eye was on them. Thus when Leon Battista Alberti took God's emblem and made it his own, the transgression reflected a shift to an anthropocentric

Figure 87: Leon Battista Alberti, bronze medal with self-portrait and winged-eye emblem at lower left, 1496, Kress Collection, National Gallery, Washington, D.C. (Erich Lessing/Art Resource, New York).

world. As we shall see, the great Nicholas of Cusa, a cardinal and a contemporary of Alberti's, responded to this challenge with a counterstrategy. It is no accident that Alberti, the first theorist of perspective, usurped the symbol of the eye for himself. In his view perspective was both a technique and a symbol of a personal gaze. An observer standing in front of a picture painted in linear perspective could feel—and wanted to feel—the same dominance toward it that people attributed to God's relationship with the world. The difference is significant. Artists had represented the eye of God in their paintings as detached, without any relationship to the rest of a picture's content; in other words, this eye was both above and *outside the world.* Alberti's eye, in contrast, projects its own gaze into a picture, where the gaze feels as though it is located *within the world.*

Alberti's emblem has eagle's wings on the upper lid, as if the eye wanted to liberate itself from the body and fly away. This eye in the emblem is also surrounded by flames, to express its bright visual power (Figs. 87 and 88).[1] In contrast to the omnipresent eye of God, human vision is limited, and if there are things the eye wishes to see it must travel to all the places where they are. The eye is quicker than the body associated with it, whose weight it is shown escaping. The wings point to its mobility, which human beings need in order to explore space and time little by little. When it is in flight there can be no fixed eye point of the kind required by plane perspective; instead the view changes constantly. The perspective gaze detaches itself from the body, however, in the sense that it enters the picture. This presages modern *ocularcentrism,* as its critics say today. Alberti's emblem of the eye faces the viewer directly, just as contemporaneous portraits first "address" us in full face, but his self-portrait preserves the old profile view, as if he could see himself from the outside.

In Alberti's case, the winged eye is the coat of arms of a human subject who

Figure 88: Matteo de' Pasti, reverse side of a bronze memorial medal for Leon Battista Alberti, British Museum, London (Erich Lessing / Art Resource, New York).

wants to become a sovereign entity through his gaze. According to the new maxim, human beings acquire knowledge by seeing and observing. On the portrait medal (see Fig. 87) the emblem of the eye appears across from Alberti's name, as if the two belonged together. Matteo de'Pasti also adopted it for his medal of Alberti (see Fig. 88).[2] The eye in this sense had already been mentioned in the text of "Anuli" or "Rings," the dialogue Alberti included in the collection of his writings known as the *Dinner Pieces* in 1431. Here, too, there is an emblem that requires a word of explanation. One of the speakers describes a crown *(corona),* "the center of which is occupied by an eye adorned with an eagle's wing." The explanation runs: "There is nothing more powerful [*potentius*], swifter [*velocius*], or worthier [*dignius*] than the eye . . . [I]t is the foremost [*praecipuus*] of the body's members, a sort of king or god [*quasi deus*]." As a good Christian, Alberti must

limit the divinity of the eye, however: "Didn't the ancients regard God as similar [*simile*] to the eye, since he surveys all things and reckons them singly? . . . [W]e are enjoined to give glory for all things to God . . . and to consider him as an ever-present witness to all our thoughts and deeds." Then he returns cautiously to the topic of his own eye: The change of emblem is a warning "to be vigilant [*pervigiles*] and circumspect [*circumspectus*]," for when we "investigate all things we emulate the divine."[3]

Despite all his caution Alberti touches on a taboo here. The isolated eye contradicts the nature of our eyes both because it appears alone rather than as part of a pair and also because it is shown separated from the body. Once it was the emblem of God, whose gaze rests on the entire world.[4] The disembodied eye had represented His all-seeing gaze, an "absolute" gaze, as Nicholas of Cusa wrote at that time (see p. 222). In a fifteenth-century broadsheet, the text that accompanies the illustration calls upon the viewer to imagine God this way.[5] Jan Provost radicalized the idea still further in a painting acquired not long ago by the Louvre. It is a learned allegory that sums up the theological worldview of the time. Hovering above the world is the unmoving and disembodied eye of God, whose equally disembodied hand holds the globe. Jesus and his mother, Mary, manifest God's incarnation. At the bottom edge another single eye looks up reverently, accompanied by a gesture of prayer. It mirrors the divine eye, having been created in the image of God, as the Bible says. It is directing its gaze in prayer to the eye of God, which draws the entire world of the picture toward itself but displays no reaction to it (Fig. 89).[6] The baroque era added a triangle to the isolated eye, as a geometric symbol of the Trinity. In this form the symbol of the eye then became the emblem of a new social order during the French Revolution.

Figure 89: Jan Provost, A Christian Allegory, ca. 1520, Louvre, Paris (Scala / Art Resource, New York).

With the isolated eye Alberti has engaged in a bold mimesis of God. His eye is a "voyeur" and a "voyager" at the same time, as Gerhard Wolf has noted with a nice play on words.[7] Since it is human, the eye must travel if it is to overcome the natural limitations of vision. Later the eye will equip itself with telescopes and microscopes and use their aid to undertake such voyages. Attached to Alberti's emblem is a puzzling and ambiguous motto: *Quid tum?* The eye becomes the subject's agent in the world, but its new freedom poses questions to which there are as yet no answers. The subject's impulse to see—his visual drive—leads into uncertain territory. The questions "What next?" or "Where do we go from here?" are also posed in the *Dinner Pieces.* The character Philoponius, whose name translates as "lover of toil," remains skeptical when he envisions the future of the arts and sciences. This uncertainty prompts him to mount the wings of his vigilant

eye so that he can fly safely above the turbulent waters in which he might otherwise drown.[8]

The new cult of the eye reaches a peak in the writings of Leonardo da Vinci, who assigns vision to the category of mental activity. A person who loses his eyesight "may be likened to one buried . . . in a grave," for vision is the only way to grasp "the beauty of the universe." Leonardo praises the eye ardently as "the lord of astronomy" and the "prince of mathematics," characterizations that would have rather surprised Muslim readers, who distrusted it. For Leonardo the eye is "an excellent thing, superior to all others created by God!" How can one praise its "nobility" adequately? The old metaphor of the eye as the window of the soul returns in an entirely new interpretation, for now the eye "is the window of the human body, through which it feels its way and enjoys the beauty of the world." Without eyes the soul would experience its "bodily prison" as torment.[9] With the help of the imagination alone we could not "visualize such beauty [*eccelentia*] as is seen by the eye," since "the imagination is to reality as the shadow to the body that casts it." It is more accurately a domain of poetry, whereas "painting puts down the identical reflections that the eye receives."[10]

Figure 90: Andrea Mantegna, detail from fresco of the life of St. Christopher, 1448–1457, Ovetari Chapel, Church of the Hermits, Padua (Cameraphoto Arte, Venice / Art Resource, New York).

The primacy of the eye also posed a problem, however; Neoplatonic philosophers who understood beauty as a metaphysical experience regarded the senses as potentially dangerous. Leone Ebreo (Judah Leon Abravanel), a member of a Jewish family in Portugal who was forced to flee to Italy in 1492, is the author of *Dialoghi d'amore* ("Dialogues of Love," ca. 1513). He sees the love of beauty as in conflict with all sensory and visual experience. The lover Philo (Filone) sometimes passes his beloved Sophia (Sofia) without noticing her, because the ideal image that he loves has become detached from her person and her physical appearance. He calls her "Wisdom"; what he loves is not a form of beauty that can be apprehended by the senses. Here, in contrast to Leonardo, it is precisely the imagination that nourishes the soul with images, not the eyes. Whereas Leonardo's work contains an Aristotelian tendency and echoes the new cult of the eye, Leone formulates a counterthesis.[11]

The art of the time finds its highest purpose in the cult of the gaze, but simultaneously the eye occurs there with a contrary meaning. When visual rays strike it like arrows and make it their target, then the eye no longer serves as an emblem of the gaze but rather depicts an organ that is constantly assailed by sensory impressions. In this inversion lies the difference between the theory of pictures and the theory of vision, whose boundary becomes visible here. In one case the eye represents the human subject who grasps the world in images. In the other case it refers

to the visual organ that receives optical stimuli and is sometimes overwhelmed by them. The second meaning occurs in the motif of the archer who aims his arrow directly at the eye, thereby giving it the same path as the central visual ray. The archer is not only a figure representing the visual ray, however, but also the painter, who strikes the observer of his painting directly in the eye through his use of perspective. The viewer then takes his painting to be the real world. Michael Kubovy speaks of the arrow in the eye as a metaphor for the art of perspective.[12]

The young Andrea Mantegna used the arrow motif around the middle of the fifteenth century in the Ovetari Chapel in Padua, when the legend of a saint offered an opportunity. A king, it is reported, once sentenced St. Christopher to die as a martyr, but the arrows intended for him were diverted and struck the ruler himself. In Mantegna's fresco the king is shown behind the window of a palace, where he intended to watch the execution. His eye has suddenly been pierced by an arrow and he is falling back, blinded (Fig. 90). Alberti has another interpretation in mind, however, when he speaks of how painters should use perspective and observes, "It is useless to draw the bow, unless you have a target to aim the arrow at." Filarete takes this thought still further when he writes that perspective should aim at the eye just as an archer aims at a target.[13] This metaphor is illustrated directly in a woodcut of the time that dates from about 1610, even though the work expresses other ideas as well. An archer has "taken aim" at the viewer as if to shoot the arrow into his eye (Fig. 91).[14] In the perspective sense this is meant much more literally than when we say we are using a camera to "shoot" a picture. It isn't the painter who is shooting the picture but the construction in perspective, which does violence to the viewer when it takes aim at his eye.

Figure 91: Jacques de Gheyn II, Archer, woodcut ca. 1610 (Museum Boijmans Van Beuningen, Rotterdam).

After the Renaissance and its fascination with perspective came to an end, the eye ceased to be an emblem of the gaze and a representative of the observing subject. In the seventeenth century it came to represent only the science of optics. A textbook on the geometry of vision was published in Antwerp in 1603 to introduce a scientific curriculum at the Jesuits' school there. No less an artist than Peter Paul Rubens drew the illustrations, which were then made into copper engravings by Theodor Gall. The title page depicts the spirit of optics on a throne, holding two symbols, the visual pyramid and a scepter with a single eye at the end (Fig. 92). An eagle and a peacock accompany "Juno Optica," who embodies the theory of perception here. The visual pyramid represents the old principle that the center of vision forms the apex of a pyramid, although the author knows that the pyramid is actually a cone. The author—Aguilonius, a name that carries a reference to the eagle—was not aware of Kepler's work on retinal images, which had

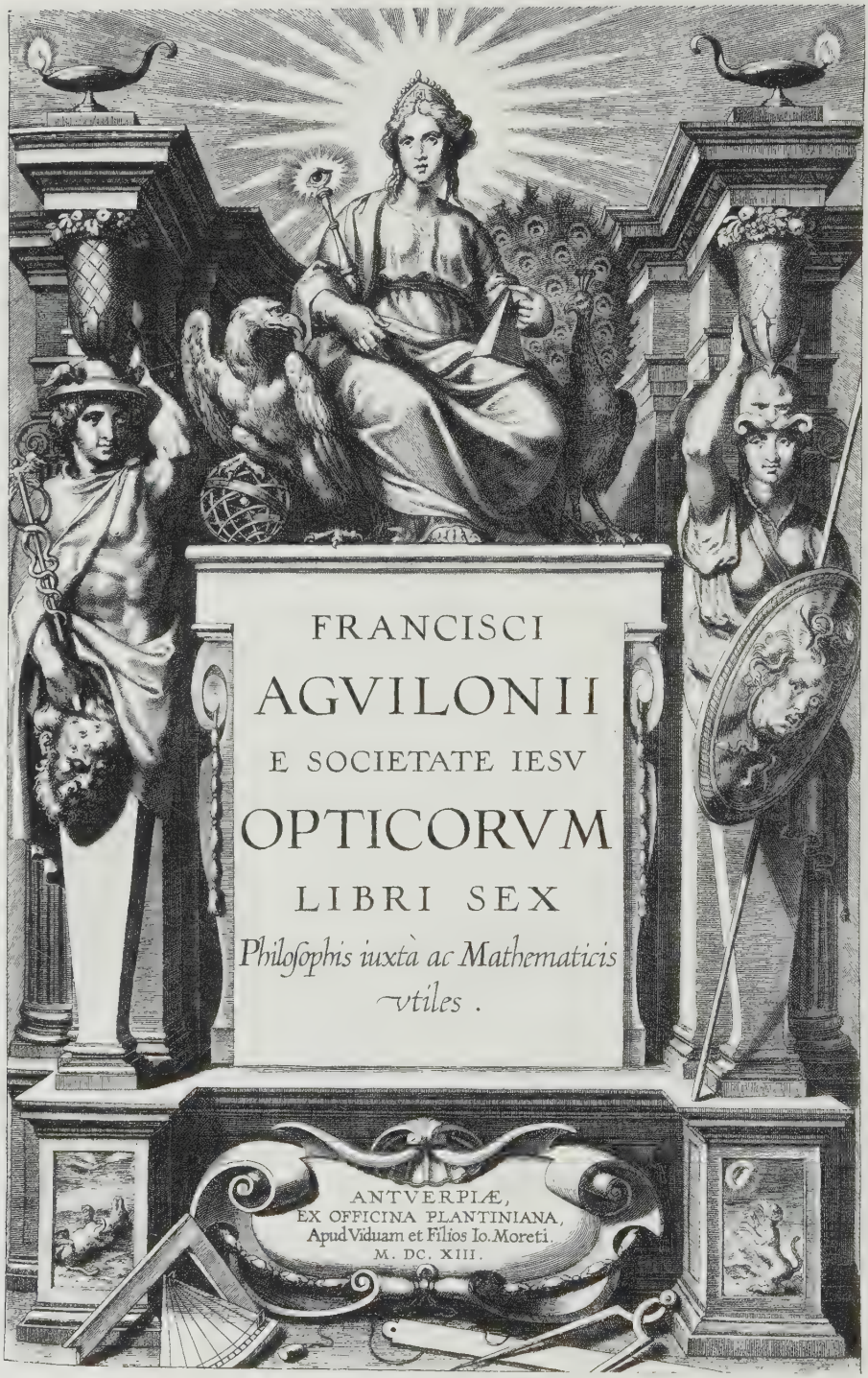


Figure 92:
Peter Paul Rubens, engraving for the title page of Franciscus Aguilonius's textbook on optics, 1613 (Franciscus Aguilonius, Lehrbuch der Optik, 1613).

appeared nine years earlier, and so he followed a theory that was already out of date. Besides the personification of optics, the illustration contains two other figures representing the gaze and its power: the god Mercury, slayer of the giant Argus, who had eyes all over his head, and Minerva, holding a shield decorated with the head of Medusa, whose gaze could kill. Science must be protected from the passions and danger. The two ancillary figures, taken from mythology and not the theory of vision, are those who can preserve us from the evil eye and its deadly might.[15]

During the baroque period we encounter the symbol of the eye taking another, equally limited meaning in the work of Nicolas Poussin. There it has become an emblem of painting as an art, instead of referring to the observing subject. In Poussin's famous self-portrait (now in the Louvre), which he created in 1650 at the urging of a friend, we see paintings stacked behind him, one of which depicts an allegory of painting. The personification is female, and she has a diadem on her head that bears an eye looking out of the picture. She is being welcomed with open arms by someone who remains invisible but in this case can only be the viewer. He is receiving her gladly, even embracing her.[16] The symbol of the eye has migrated, so to speak, since it no longer stands for the gaze that recognizes itself in painting, but for painting as visual art, an aesthetic medium that specializes in providing visual pleasure, even if, in Poussin's view, it needed a learned theory in order to do so. This is why he is holding a book in his hand, which symbolizes theory. In the age of the baroque, faith in the human gaze had shifted. The gaze was at the mercy of a world full of illusions, a world that it no longer controlled.

Nicholas of Cusa and the Sovereignty of God's Gaze

It is hardly an accident that a famous contemporary of Alberti's, the theologian Nicholas of Cusa (1401–1464), takes up a contrary position in *The Vision of God (De visione Dei).* Even though this work is often quoted, its main intent—criticism of the new perspective gaze—has received little attention until now. Nicholas, who must have encountered the humanist Alberti at the court of the Pope, offers a highly sophisticated rebuttal to the claim raised by perspective as a symbolic form, namely that the human gaze can be autonomous. In his text Nicholas

contrasts God's infinite gaze with the finite gaze of His creatures, alluding in the process to the taboo that Alberti had violated with his emblem of the eye.

Nicholas sent his treatise on the "vision of God" to the monastery at Tegernsee in southern Germany in 1453. With it he sent a new icon of Christ painted in the Netherlands and asked the monks to make an experiment by lining up together in front of it. He said they would feel the icon's gaze resting on each of them, no matter from what angle they viewed it, as if its gaze were moving from monk to monk along the row. They could thus raise themselves to the divine in a human way, since they would observe that the All-Seeing One looks out of the picture at everything around it in the same way. "Stand round it, a little way off, and look upon it. And . . . ye will marvel how it can be that the face should look on all and each at the same time." Each of the monks could walk from one side to the other, and "as he knoweth the icon to be fixed and unmoved, he will marvel at the motion of its immoveable gaze."[17] The monopoly of God's gaze could not be appropriated by a viewer who wanted to make his own gaze iconic. In saying this Nicholas was incidentally expressing scorn for the new form of portraiture, which had adopted the frontal gaze of icons.

Michel de Certeau speaks of a geometry of the gaze, which the monks were supposed to orchestrate together.[18] We can take this thought a bit further: If they took up whatever position they liked in front of the icon and still saw the same thing, then they invalidated the new perspective, which contained only a single viewing point in its calculations. Every individual in the group experienced his gaze as limited and interchangeable. In such a situation no one's gaze could be that of a unique observing subject; no one could view the icon in a different way than his neighbors. Hence the icon's gaze was preeminent, and it, in turn, symbolically represented the absolute gaze of God. If the painted eye could see all of them together and each individual at the same time, how much more must this be true of the absolute gaze, in which all human gazes—as then authorized by perspective—were subsumed.

Nicholas comes to speak of visual theory when he emphasizes the anatomical and physical limitations of the visual organ. "The sight of one man is keener than that of another among us . . . one will with difficulty distinguish objects near him, while another can make out those at a distance." Absolute Sight, however, has none of the limitations of human vision, which is "narrowed down to time and place, to particular objects, and to other like conditions." Human beings are subject to changing partial views, corresponding to their existence as ambulatory creatures and to a gaze that could move with them. We have a limited angle of vi-

sion, but this was not the case for the small portrait of Christ that Nicholas had given the monks. In that icon they could see a faint reflection of Absolute Sight, which Nicholas recognizes as the model for all other forms of vision. "All limited modes of seeing exist without limitation in Absolute Sight."[19] This is the counterposition to the perspective picture, which is constructed to serve only one focal point and seeks to make that view absolute. The gaze of icons differs from a perspective gaze, which inserts itself into the picture as the artist chooses.

Nicholas was aware that the artist who painted the icon had used a special technique to simulate an omnipresent gaze, and so he mentioned parallels, portraits whose subjects also follow a viewer with their eyes. In a painting "in the governor's house at Brussels," which was actually a fresco, he had recognized the famous painter Rogier van der Weyden by a gaze from the picture, which one had to go looking for since the painting contains so many figures. In the very next sentence Nicholas mentions "the Veronica in my chapel at Coblenz," where the effect of the gaze is similar. This was one of the replicas of the "true icon" of Christ in Rome, of which many existed throughout Europe (Fig. 93 is an example of one painted by Jan van Eyck).[20] The icon that he sent to the monks at Tegernsee—before which they were supposed to carry out the experiment as Nicholas wished and distribute their gazes throughout the choir of the church—must have been just such a picture.

Nicholas's meditation on the all-seeing gaze of God went still further: Whereas the "visual forms" *(species)* reach "the mirror of the eye" only singly and at a particular angle of vision, God's sight is unlimited in space and time, in conformity with His nature. The Greek word for God, *theos,* is related to the Latin word for sight, he states: "God . . . is called θεός from this very fact that He beholdeth [*intuetur*] all things."[21] The icon consequently depicts a gaze that could be described as absolute. With his keen intelligence Nicholas relates the theme of optics and mirrors to the old theological discourse. The mirror is the Form of forms and captures all the individual "visual forms" in which we perceive objects in the world. And yet, he says, a mirror is only a metaphor for the "living mirror of eternity." Hence no viewer perceives his own appearance in the icon as he would in a polished mirror made of glass—quite the contrary in fact! In "that mirror of eternity what he seeth is not a figure, but the truth, whereof the beholder himself is a figure."[22] Here Nicholas reverses the metaphor of the mirror, which was so central for the new perspective. In the case of the icon, we are viewed by the One "in whose image we are made" (Genesis 1:27).

Paintings in perspective expressed their own limitation simply through being

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surrounded by a frame, which in a manner of speaking "cuts out" a view of the world and makes it into a discrete visual space. Nicholas of Cusa was aware of the revolution that was on the horizon. But he opposed the anthropocentric symbol, in which the subjective gaze feels autonomous, with his theocentric argument that expresses the meeting of the Middle Ages and the modern period: a Janus figure with two heads, each facing in opposite directions.[23] For him finite being is reflected in the infinite, and the finite gaze in the gaze of an unlimited wholeness. Gottfried Boehm has spoken of the sense of self that finds expression in perspectivism; for Nicholas this personal selfhood is still related to the "divine horizon, both infinitely close and infinitely distant."[24] His metaphysics are in their own way—a very different way—perspectivist. The theologian's controversy with the humanist Alberti (which was carried out without any names being named) only goes to show how problematic it was to maintain a balance between the perspectivist gaze and the theocentric icon.

The same problem emerges in the field of art in the work of the Flemish painter Jan van Eyck, a contemporary of Nicholas of Cusa. Searching for a way to synthesize icon and portrait, he ended by upholding their separation into two different genres of picture that cancelled each other out. The "true icon" of Christ, which he "modernized" with a black background and physiognomy following the norms of a contemporary portrait, is signed by the artist and has a date of composition that in other cases documents when the model sat for him (see Fig. 93). Yet the way Christ gazes at us is still abstract, like an icon—it is an "absolute gaze," as Nicholas put it. The divine gaze, even if it is embodied in the human being Jesus, is not related to the viewer as part of a dialogue; it is "without limitation" and has the character of a monologue. It is precisely in the gaze that van Eyck restores the norm of the old icons, the norm that was then being challenged by portraits.[25] Thus in van Eyck's panel painting there arose—as Nicholas of Cusa would have said—a coincidence of opposites.

Figure 93: Jan van Eyck, Portrait of Christ, signed by the artist, 1438, State Museums, Berlin (Bildarchiv Preussischer Kulturbesitz / Art Resource, New York).

Yet in the portrait, which he saw as the converse of the icon, the Flemish painter pushed the boundaries further than any artist before him. In creating the first self-portrait in the history of art, he took a radical idea to its limit, so that the portrait emerged from the shadow of the icon. This painting, which today hangs in London, shows van Eyck scrutinizing himself in the mirror in order to make a permanent record of his appearance (Fig. 94). A person's image in a mirror is the antithesis of an icon, as Nicholas of Cusa observed. The artist's face looms up out of the dark room in Bruges where he completed the work in October of 1433. He has recorded not only *what* he saw as he painted his own double, but also exactly *how*

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he saw himself. He is looking at "himself." But what is this self? It consists not only of a physiognomy but also of two gestures: self-assertion and reassurance that this self exists. The chosen motto written on the frame—*als ich chan* ("as well as I can")—emphasizes his invention of a pictorial technique with which he can take his own gaze, so fleeting and mortal, and make a lasting image of it. It was not just a matter of taking a mirror image and copying it mechanically, since at that time van Eyck did not own an expensive flat mirror and had to rely on a convex one. Since he could not paint a simple equivalent of his own reflection, he had to simulate the reflection of a plane mirror in the work of art. The mirror is thus not simply an aid in the task of depicting a face; rather it symbolizes the project of finding a form to represent the self and being an observing subject.[26]

This is why we can speak of a sovereignty of the gaze in panel paintings, for which the same term "shield" was used, as for an escutcheon *(Schild—Wappenschild—Tafelbild).*[27] Sovereignty of the gaze means the right to a painting and presence in the painting. In the case of the Van Eyck self-portrait now in London, it was the gaze of the artist that achieved representation. He was dependent on each later viewer, of course, in order to become a subject in the viewer's gaze, or to remain a subject. Yet viewers in that era sought, if not their own face, then at least their own gaze in every perspective work of art. This also holds true for Flemish painting, even if it did not make use of mathematical perspective but developed an alternative that cultivated the empirical evidence of physical objects and their surroundings. Van Eyck painted his self-portrait during the same period in which Alberti was writing his treatise on painting. We must identify paintings as a symbolic form, too, just as in Florence it was the perspective mode of depiction that accompanied this development from the start and determined its direction. The painting, with its window symbolism and transportable character, was a symbolic form in that it expressed the analogy with a living person and his or her gaze.

Figure 94: Jan van Eyck, Self-Portrait, 1433, the first self-portrait by an artist, National Gallery, London (© National Gallery, London / Art Resource, New York).

The Subject as New Narcissus

In the same work in which Alberti first expounded the theory of perspective, we also find a new interpretation of the story of Narcissus that turns the myth upside down, so to speak. If we want to understand perspective as a symbolic form and a cultural technique in its full cultural and philosophical context, then it is essen-

tial to take a closer look at this reinterpretation and the framework in which Alberti placed it. Alberti speaks of Narcissus as the inventor of painting, although of course he knew that Narcissus himself was not a painter. The activity that characterizes Narcissus was *looking,* and he remains an observer here, too. Yet in the ancient myth the young man did not realize he was looking at a mirror image and had no conception of what that was. As Alberti retells the story, however, we encounter a Narcissus who does not lose himself in his own reflection but finds himself in art. The meaning of this unexpected inversion becomes clear if one does not limit it solely to art—even though that is all Alberti mentions—but realizes that here the subject is making his first appearance, the conscious subject who recognizes his own gaze in the new perspective painting. The gaze plays a similar role in Alberti's symbol of the eye and his interpretation of the Narcissus myth, for in both cases the subject, as a new Narcissus, takes possession of the world in his own gaze. By developing a new technique that made this possible, painters placed their gaze in the picture for the first time.

This turn of events is all the more surprising because in many respects antiquity had imposed a taboo on the gaze. Narcissus's encounter with his own gaze had a fatal outcome, and this was nothing but a metaphor for encounters with a mirror. Danger lurked there, for a person could lose his self or his life in his own gaze.[28] When Alberti gave a positive twist to the myth, Narcissus was no longer the victim of a forbidden gaze but became a new Narcissus who could entrust himself to his own gaze.[29] The "iconic gaze," as the pictorial gaze may be called, leads not to death but to a picture—admittedly, a picture that has been transformed by a new kind of art. The old Narcissus desired another in his own reflection, not himself. The new Narcissus casts a glance at himself as well, but he finds himself in the picture because he can distinguish the picture from reality and learns to understand its symbolic character. As a place of representation and not a place of life, the perspective picture offers distance and safety to a viewer. The picture becomes separated symbolically from the person who views it, yet the very process by which this occurs leads him back to himself. For an understanding of what follows, however, it is essential to expand the definition of the mirror image of the self, since otherwise it would be possible to speak only of portraits. This expansion consists of discovering the role of the gaze and the gazing observer in all perspective painting, or, to put it differently, what leads to a new Narcissus is a personal gaze directed at the world, not just at oneself.

First, however, let us take a closer look at the text in which Alberti speaks of Narcissus. A painting, he says there, is like the surface of a pool of clear water un-

disturbed by motion.[30] Such a natural "mirror" of water also reproduces a three-dimensional world on a plane surface. With his "art" a painter thus imitates what he was able to observe in nature. The analogy between a mirror of water and a painted canvas—even though an unchanging surface in a pool runs counter to all experience of nature—sets up an equation in the relationship between nature and art in which the picture fulfills the commandment of realism. People who experienced the invention of perspective were clearly fascinated, above all, by the way puzzlingly evanescent reflections, in which the world becomes visible, were suddenly frozen, turned into permanent images in art. Precisely the same thing happens when the fleeting gaze is turned into a picture. The same experience, namely that one's own gaze has been fixed forever, also surprised people who saw the first photographs—more than the photographs themselves. Every experience of a mirror requires a gaze, for otherwise no mirror images can occur. The world becomes visible in a reflection without actually being in the place where we see it. It is only our gaze that places it there. The same is true for paintings transformed by perspective; this transformation was repeatedly explained in terms of mirrors by contemporaries from Brunelleschi to Filarete (see Chapter 5). Thus before people became used to the mimetic art of perspective, it opened up a dizzying abyss of self-experience. If we read it carefully, this theory of art was above all a theory of the gaze, and with the gaze the observing subject came into play.

Let us continue reading the text in which Alberti speaks of Narcissus: "I used to tell my friends that the inventor of painting, according to the poets, was Narcissus, who was turned into a flower; for, as painting is the flower [*flos*] of all the arts, so the tale of Narcissus fits our purpose perfectly. What is painting but the act of embracing [*amplecti*] by means of art [*arte*] the surface of the pool" in which Narcissus saw his image? (2.26). Alberti is making a play on words here, since one cannot "embrace" a picture but only another body. His readers were familiar with Ovid's *Metamorphoses,* which tells how Narcissus loved "a hope without a body" *(sine corpore)* and "took to be a body what was only a reflection in the water" *(unda).*[31] Alberti reinterprets Narcissus's unsuccessful exchange of glances as a glance at art, a glance that changes everything. The fleeting deception in the myth returns in painting as art. This interpretation of Narcissus has no model in antiquity, and indeed could not have existed then, since the myth had exclusively negative connotations. "The dilemma of Narcissus seems to have been solved for painters," Gerhard Wolf has observed, when the crime of idolatry was transformed into an interpretation of the self founded on both art and philosophy.[32] Only *art,* as it was newly understood, legitimated the once-forbidden gaze. A

painter was now a participant who translated the direct gaze into art. The "paradox of embracing a surface" transformed the gaze from a taboo into a symbol.

Of course Narcissus does not number among the inventors of painting mentioned in antiquity—how could the Roman historian Pliny have included a mythical figure among them? Alberti is not interested in "writing a history of painting like Pliny," however, but in formulating "an entirely new theory of art. On this subject there exist today none of the writings [*monumenta*] of the ancients, as far as I have seen" (2.26). He surmises that perhaps some ancient works have been lost. Nor are any references to Italian painting, which flourished among the Etruscans, to be found in ancient "works of literature" *(monumentis litterarum).* What makes painting into art is a new theory. Science and art join forces to promote implementation of the individual gaze. Science gives sanction to art with a theory that made art into a privileged space for encounters with the self. With astonishment the subject recognizes himself as a "modern" Narcissus, who creates himself anew in the symbolic gaze of self-knowledge instead of falling into the trap of his own gaze.

The myth of Narcissus, just like the myth of Medusa, was an expression of ancient culture that stood in irreconcilable contrast to the modern era. Narcissus lost his life in the dark mirror of the water. Actaeon was punished for having glimpsed the virginal Diana at her bath. Orpheus lost Eurydice a second time when he turned around to see her shade and his gaze crossed the forbidden threshold between life and death. Apotropaic spells and amulets served to "turn away" the evil eye, as the Greek word *apo-tropein* says. The gaze of the Gorgon and Medusa transformed their victims into stones without eyes, that is, into images of the dead, who could no longer return a gaze. All life perished in the gaze of the Gorgon. The dead were stone images in this world and shades without bodies in the other. When Perseus showed the Gorgon her own face in a mirror, she became a victim of her own gaze.[33]

Ancient people were afraid of the eye "whose gaze brings terror," as Roger Callois has written about the myth of Medusa. They took care to avoid the baleful orb "that causes dizziness and brings about death."[34] As Pascal Quignard writes in his essay on terror and fascination in antiquity, Narcissus was killed not by self-love but by the gaze.[35] Antiquity was "filled with fear about the act of seeing" and believed that the eye was capable of emitting material substances. Seeing was understood as a violent, sexual, ominous act. The frontal gaze was forbidden, and the gaze had to be averted from mirrors. Fascination takes possession of everyone who can no longer avert his gaze.[36] There may be a certain exaggeration in this, as

in every general statement, yet the fear that existed in antiquity in connection with our topic is a backdrop before which the new utopia of the gaze is clearly outlined.

In ancient paintings Narcissus usually avoids gazing into the water, where his dark reflection looms up like a death mask with empty eye sockets. It seems the painters in Pompeii wanted to hold up the progress of the tragedy and leave its ending open (Fig. 95).[37] Philostratus, who in his famous work *Eikones* (or *Imagines*) describes an art gallery in ancient Naples, includes a discussion of a painting of Narcissus and calls out a warning to the youth that he should avert his eyes from this likeness *(eidos),* for the shade *(skia)* is only returning his own gaze.[38] The shade in the mirror intensifies the connection to death, since it was believed that the dead lived on as shades in Hades. If we turn to Ovid, then what Narcissus could see in the water was only his shadow reflected back to him (*Metamorphoses* 3.434). "Like its Greek equivalent *skia,* the term *umbra* denotes a reflection," but *umbra* can also mean "phantom" or "ghost," another form of disembodied impermanence. Narcissus is first reflected and will then turn into a shade in the sense that the dead are shades.[39] Reflection and self-love are related, since self-love occurs in the gaze. Only reflection in another sense would create distance and the realization that one cannot see oneself as others do. We cannot see ourselves in the flesh but only in the mirror.

In ancient times, experiencing oneself as an image led to death. The dark mirrors made of bronze revealed the future to those who looked into them, since once they were dead they would live a shadowy existence in the underworld, resembling their dead bodies only as an image resembles an object. Ancient mirrors became reflective only when the bronze surface was repeatedly polished.[40] Even the Platonic doctrine of appearances and shadows could not eradicate an old belief in the magic nature of mirrors. The reflection in the mirror could cause death if it took possession of the soul. An abyss opened between the living observer and the image that could not be closed with art, as in the Renaissance. Mirrors were objects of fear and fascination in antiquity, especially because, despite Ptolemy, there was no optical theory that provided a rational explanation for phenomena as was developed after Alhazen. There was a famous mirror in front of the temple of Despoina in Arcadia, Pausanius reports, in which visitors to the temple could have a twofold visual experience. They regarded the very dim *(amydros)* reflection of their own faces as a call to cleanse themselves of their self-image. And then in the same mirror they glimpsed images of the goddess "quite clearly," before they beheld her statues within the temple.[41]

Ovid's retelling of the myth has no doubt left its stamp on the theme of Narcissus more than any other text. In his philosophical meditation on metamorphosis as a law of the world, the dead Narcissus is transformed into the flower that blooms anew every spring. But at the heart of Ovid's story lies the splitting of the ego that in self-examination becomes self-love. The prophecy runs: Whoever

gazes at himself places his life in danger, for he sees his death. The only one who will live is the one who "does not know himself," that is, who does not see himself (*Metamorphoses* 3.348). In gazing at himself Narcissus is transformed prematurely into an image of his own death (3.430). Life freezes within him, and he is like a statue carved of Parian marble (3.419). "He gazes at that false image with unsated eyes, and loses himself in his own vision" (3.439). "What you perceive is the shadow of reflected form: nothing of you is in it" (3.433). The split between the self and image is an experience of mirroring. Even reflecting on what could save him—"I am he" (3.463)—is unsuccessful in Narcissus's case. When "his tears stirred the water, and the image became obscured," he cried out desperately after the image, "Where do you fly to?" (3.475).

Ovid's Greek sources have been lost. The only other testimony we have from this tradition comes from his contemporary Conon, who explains that Narcissus was punished because he rejected all declarations of love.[42] Despair at being rejected himself led him to commit suicide. Among Ovid's successors, Philostratus, who was mentioned above, stands out for his depiction of Narcissus influenced by the rhetoric of the Second Sophistic. Philostratus reflects on an aesthetic point, namely that "the pool paints [*graphei*] Narcissus, and the painting [*graphe*] represents both the pool and the whole story of Narcissus."[43] In competing with the painting, Philostratus retells the myth in as "painterly" a manner as possible but without referring explicitly to the problem of the picture. Instead he mitigates the problem when in the fictitious dialogue he calls out to Narcissus that he has not been deceived by a painted picture *(graphe)* but by a mere reflection in the water. This indicates that an effort is being made to keep art out of the tragic story of a mirrored self.

Figure 95: Fresco depicting the myth of Narcissus, first century CE, house of Cornelius Tèges, Pompeii (Scala / Art Resource, New York).

In his new interpretation of the Narcissus myth Alberti contested both that of antiquity and the negative view of Narcissus in the Middle Ages. In the Christian version of the myth known as the "moralized Ovid," Narcissus is forced to realize that he himself is an image of God and that this image can be found only in his soul, not in his mortal body. Death is his punishment for the illusion of self-love. Visual pleasure stands in the way of all higher knowledge, since it inevitably leads to idolatry.[44] In Dante's *Inferno* two perjurers mock each other, one saying that the other would not hesitate to "lick the mirror of Narcissus" to slake his thirst.[45] In the *Paradiso* Dante first takes the souls he sees to be reflections of the kind that "inflamed love between a man and a fountain" (3.18). In heaven the laws of nature are suspended, however, and the "reflected similarities" *(specchiati sembiante)* of

the souls have more substance than the "reflections" *(postille)* that deceive us on smooth and transparent surfaces (3.13).[46] As Gerhard Wolf has observed, Christ appears as a "positive Narcissus" in the works of both Dante and Petrarch.[47]

Seen against both the ancient and the medieval background, Alberti's interpretation of Narcissus stands out as an indication of a turn toward an anthropocentrism that was obstructed by the ancient myth. Gazing into a mirror no longer represented a taboo and promised the subject insight and self-knowledge in the stage of his growing self-awareness. The gaze was not lost in the water but found in perspective painting. In this milieu the mirror became a key concept. Paintings had a decisive advantage over mirrors, however, at least until the spread of plane mirrors in the seventeenth century. They did not function automatically but were artifacts with all the uncertainty that an external gaze and hand could contribute. Nevertheless, people welcomed the fact that paintings could freeze the mirror image (as photographic prints would do later) and the fleeting reflection of the mirror. For this reason the painting was celebrated, like the photograph after it, as a new form of mirror with a permanent image.

The portrait was predestined to be connected with the new Narcissus if one takes Alberti's understanding of it as a basis. Countless portraits contain allusions to mirrors, but they are not ordinary mirrors on which images come and go. Instead portraits freeze the reflection, if one can still refer to it as such, since it is painted and even outlives the person depicted in it. The self-reference of the sitter was controlled and at the same time sanctioned by the intervention of the painter. This is different in the case of the self-portrait, in which the artist paints his own mirror image. In the small self-portrait, now in Vienna, with which the very young Parmigianino introduced himself in Rome in 1523, the artist distances himself from the mirror he used by painting its convex surface rather than his face alone. This work is unique in its genre because of the split between the mechanical mirror image and the self that looks into the mirror as if it were genuine and not a painted one (Fig. 96).[48] The painter registers the curved surface of the mirror, which brutally deforms his appearance, as if he were a neutral observer of an experiment. Vasari was fascinated by the uncanny resemblance of the small round portrait to a genuine barber's mirror, both in its format and even the curved surface of the wooden panel. The painter has preserved only what could actually be seen on the surface of the convex mirror—an instance of painted catoptrics. The hand near the mirror appears gigantic, while the small head recedes into the space behind.

Figure 96: Parmigianino, Self-Portrait in a Convex Mirror (1523), Kunsthistorisches Museum, Vienna (Foto Marburg/ Art Resource, New York).

The deformed mirror image represents a victory of the new Narcissus over the source of his ancient error, but it is also a criticism of mirror perspective in painting. By this means—by ironically questioning the analogy of painting with mirrors—Parmigianino introduced mannerism. Nevertheless the theory of vision (in the mechanical function of the mirror) only appears to triumph over pictorial theory, since the subject thereby frees himself from dependency on the mirror reflection alone. Parmigianino, as a person and as a face, differs from his mirror image. The whole maneuver becomes thoroughly paradoxical by the artist's insertion of his own outsized hand between the mirror and the gaze. The painter could have used his hand to correct the mirror's image but chose not to. In addition the hand appears to be his right hand only because the mirror has reversed the image,

but he is not shown painting with his left hand either. Almost as if by accident there is a hint at the right edge of the painting that the artist is working on a small round panel, just like the one we are looking at. But then what *are* we looking at? Is it a mirror or a painting? Here the mirror returns to the art of portraiture, but as a phantom.

There are other puzzling pictures from the sixteenth century as well that deal with the fragile equation between mirror and painting but question it at the same time. One original instance is offered by a portrait of an architect in which the sitter is looking into a mirror and sees the face of the artist beside his own. The architect, who in the mirror resembles Michelangelo, is looking into his own eyes but is pointing to the painter, who is directing his gaze past the mirror image toward his model. The painter and model are competing for the space in the mirror. In the last analysis, however, the painter is the mirror of the architect. As Savonarola once said, painters always paint themselves. Hence here we see a double Narcissus in a single picture (Fig. 97).

Figure 97: Bernardino Licinio (?), Portrait of an Architect (?) and Self-Portrait of the Artist, between 1520 and 1530 (Martin von Wagner Museum der Universität Würzburg).

In this period painters seldom depicted the myth of Narcissus as it was understood in ancient times, for that could only have led back to the old Narcissus. It was counterproductive to recall the negative interpretation of Narcissus when artists had long since started to feel that they were a new Narcissus who—instead of leaning over a pool of water—was creating his own image. Among the few exceptions is a work by Caravaggio, but his interpretation of the myth is highly uncertain, and it cannot be cited as continuing the traditional theme, precisely because it represents such an anomaly.[49] In Caravaggio's painting Narcissus is shown kneeling, with one knee forward, bent over the dark surface of the water as if he wants to plunge in. He can never "embrace" the water, however, because he would run the risk of drowning. The reflected image is so unclear that one has to wonder whether the artist still considered it the central theme. The reflection remains a tragic illusion, which is refuted by all the evidence of life in the body bending over it. Possibly the artist's gaze wanted to force formlessness into a form. Yet Caravaggio's treatment of the theme is so idiosyncratic and ambiguous—as is the case with his treatment of all themes—that it does not amount to a simple depiction of the ancient myth. In his era the interest in the ancient myth had shifted, as other examples show. I will name only one here: In Poussin's painting on the theme of Narcissus and Echo, now in the Louvre, the interpretation of the myth has been altered in a notable manner. Narcissus's gaze into the pool is not shown at all; instead the young man is already dead, lying next to the water. Only his foot is reflected in it, while Echo is depicted mourning him in the background. Since

his voice can no longer be heard, her echo has also died away. Nevertheless a cupid with a torch invites us to observe the narcissus blossoms that are springing to life again next to the dead young man.[50]

The invention of the new Narcissus creates a metaphor for the gaze in a positive sense, which in turn provides the key to the perspective model of painting. Yet for artists the gaze did not by any means retain the same significance that it had in the Renaissance; its meaning changed constantly as the modern era progressed. In the Renaissance the gaze goes out into the world, so to speak, since it feels itself as the master of what it perceives. With its inquisitive eye the gaze takes up a position at a site it has chosen itself. But the narcissistic impulse overrides this ability to choose and becomes self-referential instead of depicting the world; in fact it develops into the high art of deceiving the eye. The gaze that has imprisoned itself must be content with the only freedom it now has, namely its own tricks and illusions. It allows itself to be enticed by art in the chambers of the imagination, where it becomes pleasurably lost in phantasmagorias and visual riddles. Images produced by technical means, which take over the tasks of observing nature that art neglects, put the eye to shame. Art and the culture of the gaze have changed course, and the interplay between the gaze and images has embarked in a direction that takes the gaze beyond itself without satisfying it. Now fears arise that can be driven away only by taking pleasure in illusions.

The Horizon and the View through a Window

Two metaphors sum up the new visual culture of perspective: the window and the horizon. They belong to different categories and thus cannot be compared directly, but both are connected to the gaze ,and their relationship resembles the one between eye point and vanishing point. Real or painted windows symbolize the location of the observing subject, who is looking out the window at the world. The horizon, in contrast, symbolizes the limits of the gaze, which empirically reaches no further. Perspective operates between the eye point and the vanishing point. The eye point needs a window as a frame, and the vanishing point lies on the horizon. As a concept this was old, but it was not measured until the perspective image came along.

It was a turning point in cultural history when artists linked the horizon to the

human gaze and ceased relating it to a transcendental gaze that looked down at the world from above, as had been the case in medieval times. Between the eye and the horizon there is a space that can be measured, a visual space *(Seh-Raum),* and so the horizon is now a way to measure the gaze as well as space. Space as measured in human terms becomes synonymous with visual space and dependent on a gaze from a human body. Since the eye can be deceived, the area of the gaze must be measured. Of course the horizon can demarcate the threshold to a "beyond," but in the perspective image it points to a "before," the place where the gaze resides. While in some cases it can mean *absence,* in perspective it is a symbol for *presence,* since it is predicated on the existence of an observer in whose gaze the horizon first takes form. In a framed picture the horizon is a necessary partition of a visual field, yet at the same time it symbolizes the visibility of the world.

The meaning of the horizon has undergone many cultural changes; in fact Albrecht Koschorke has written a "history of the horizon."[51] In this history, however, the horizon, as perspective painters understood it, occupies a distinctive and unmistakable place. In the early Renaissance, with its confidence in visual recognition of the horizon, it was regarded as "dependent on an observing subject," so that it changes when the subject changes position.[52] Yet if the receding horizon permits only a limited view of the world, then its determination in a perspective picture can have only one meaning, namely to calculate and measure the space in front of it. The "discovery of the horizon," which Koschorke calls a "boundary-figure of immanence," coincides chronologically with centering paintings on an observing subject. "The surface of the painting becomes the scene of tension between subject-centeredness and the flight of the gaze to infinity."[53] Mathematical perspective makes distance from the eye the sole guideline, in contradiction to every ontology of the image. Visual space in perspective art is not simply "natural" but rather "dependent on mathematical substructions."[54]

The horizon becomes an integral part of pictures in plane perspective. In diagrams by Serlio and Vignola (see Figs. 3 and 4) a horizontal line leads from the eye to the horizon. As a measurable quantity it is linked to the body, whose eye point gives rise to the whole construction. Contemporaries were so enthused by this advance that they soon wanted to attempt even more, namely, to calculate the dimensions of the planetary system; this proved to be a utopian aim at the time. One such an attempt appears in an edition of Vitruvius translated and illustrated by the Milanese architect Cesare Cesariano in 1521 (Fig. 98).[55] There the *orizontis linea (AB)* is solemnly entered at eye level. All that could be measured, however, were the visual rays that lead to the baseline *(CD),* where a grid has been

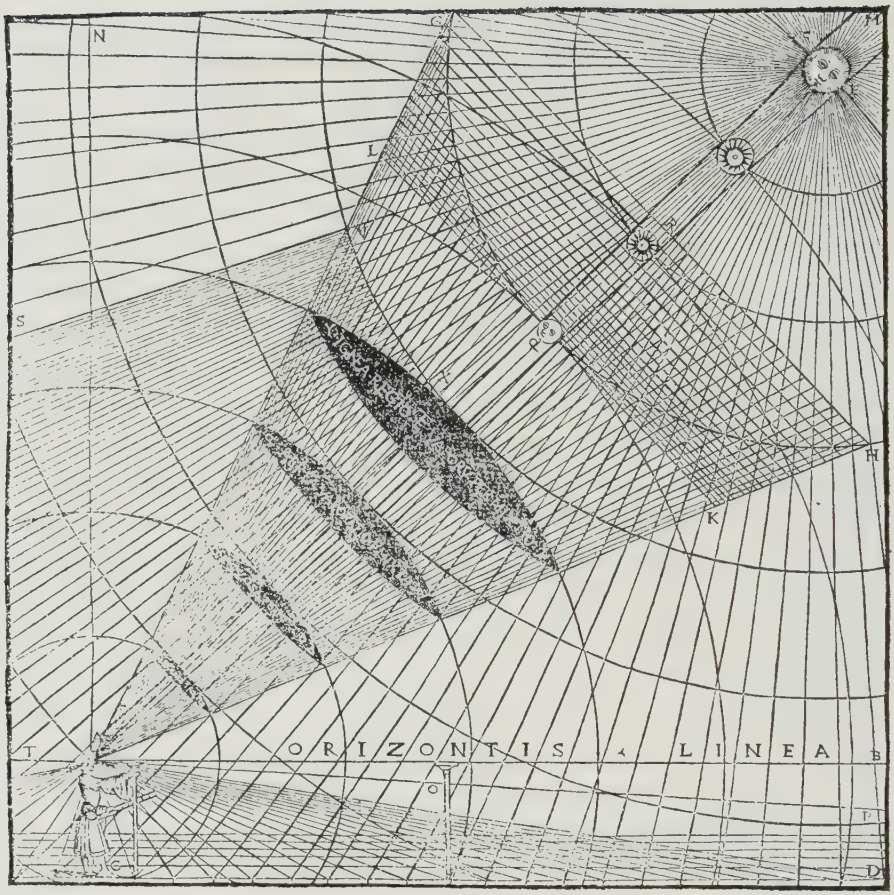


Figure 98: Cesare Cesariano's View of a Planetary Perspective, from his edition of Vitruvius's De architectura, 1521.

placed between the distance point *(C)* and the edge of the illustration *(D)*. The view into space where the sun and planets are revolving has no fixed points that the measurement can reach. The visual pyramid is of just as little use here. Cesariano writes enthusiastically about the "imagined center" of the eye, but no "planetary pyramid" exists that could measure any desired distance from that center with a compass. The anthropocentric gaze, whose importance he so greatly overstates here, remains earthbound.

Nevertheless, or for this reason, the horizon at the vanishing point represents a new terrestrial infinity in the horizontal. It promises a goal for the gaze that is solely a mathematical quantity, however. The gaze here goes beyond itself and mirrors itself at the same time; hence we must question the figure of the astronaut who leaves the world in the vanishing point, since the journey is not one to the

stars.[56] Descriptive geometry must "postulate a point at infinity as its origin" in order to locate a projection on a plane, as the mathematician Brian Rotman observes.[57] "Zero is to number signs, as the vanishing point is to perspective images, as imaginary money is to money signs."[58] The vanishing point altered the world of images just as much as the zero altered algebra. Simultaneously it is "the anchor of a system which *incarnates* the viewer."[59] In perspective portrayal it is a zero from which all magnitudes and distances can be calculated, and for this reason it cannot be represented, even though the entire image is organized around it. One can find its location in diagrams, but paintings—just like our empirical vision—can only postulate its geometrical location.

The same holds true for the horizon, which culminates in the vanishing point. It is implied everywhere, even when closer objects or events—interior settings, a narrative—intervene. One might almost regard an invisible horizon as a principle, since it is of a very different nature than the world of objects. Just like the vanishing point, it does not belong to the category of things an artist can depict or the category of signs that refer to objects. Of the three city views from Urbino, only one (the painting now in Berlin) shows a horizon, and that is only because the city lies on a seacoast (Fig. 99). The city was necessary in order to reproduce the world in perspective, and the horizon was necessary as an interpretative key. The artist has avoided marking the vanishing point, however, and instead has placed a tiny ship next to it as a way of emphasizing its invisibility. There is another example in which we encounter the same attempt to distinguish the horizon from everything else in the picture, namely a perspective model diagram by Jan de Vries. There the horizon line is drawn in, not as part of the depicted architecture but only to indicate the artist's construction, while the vanishing point is blocked by the back of the observer's head (Fig. 100).

The *window* is an entirely different phenomenon from the horizon. It was used from the beginning as a defining term in the perspective revolution and serves in many texts on perspective as its chief metaphor and model. In a genuine window the objects viewed appear *behind* the opening whereas in a painting they are projected onto an imaginary window pane in order to achieve the same effect. Leonardo instructs artists to draw the outline of a tree on a pane of glass; it is through the glass that one sees the actual tree. At the end of the process they are to compare their drawing with the genuine tree behind the pane, looking at the tree on the pane with one eye and the tree behind the pane with the other.[60] Leonardo understood perspective, in a nutshell, as a view of the world on a pane of glass, on the surface of which "everything is drawn that is found behind the pane."

Figure 99: City panorama, from Urbino ca. 1470 (detail from Fig. 78), State Museums, Berlin (Bildarchiv Preussischer Kulturbesitz / Art Resource, New York).

Dürer translated the new Latin term *(perspectiva)* as "seeing through," in connection with the ancient verb *per-spicere* in the sense of "perceive," namely as seeing through the plane of the picture. This makes sense only when a screen exists through which one is seeing.[61] In the Italian translation *prospettiva,* which painters adopted, there is also a connotation of "view" and "vista."

Alberti transferred the old metaphor of the eye as a "window to the soul" (Heraclitus had called the senses the window of the soul) to the painting, describing it as a window. The eyeball, seen from outside, is a round mirror on whose surface the environment is depicted, but in the dark opening of the pupil the gaze comes out as if through a window. What was known as *perspectiva naturalis* always referred to the "window view," as if it were natural to gaze at the world through a window. This could appear natural only in Western culture, and it was here that what is called the "perspective window" was invented, which gave painters an easier form of control over the picture than mathematical perspective did.[62] Later the expression "perspective" came to be a common term for the spyglass or telescope, closing the circle between *prospect, perspective,* and *window.*

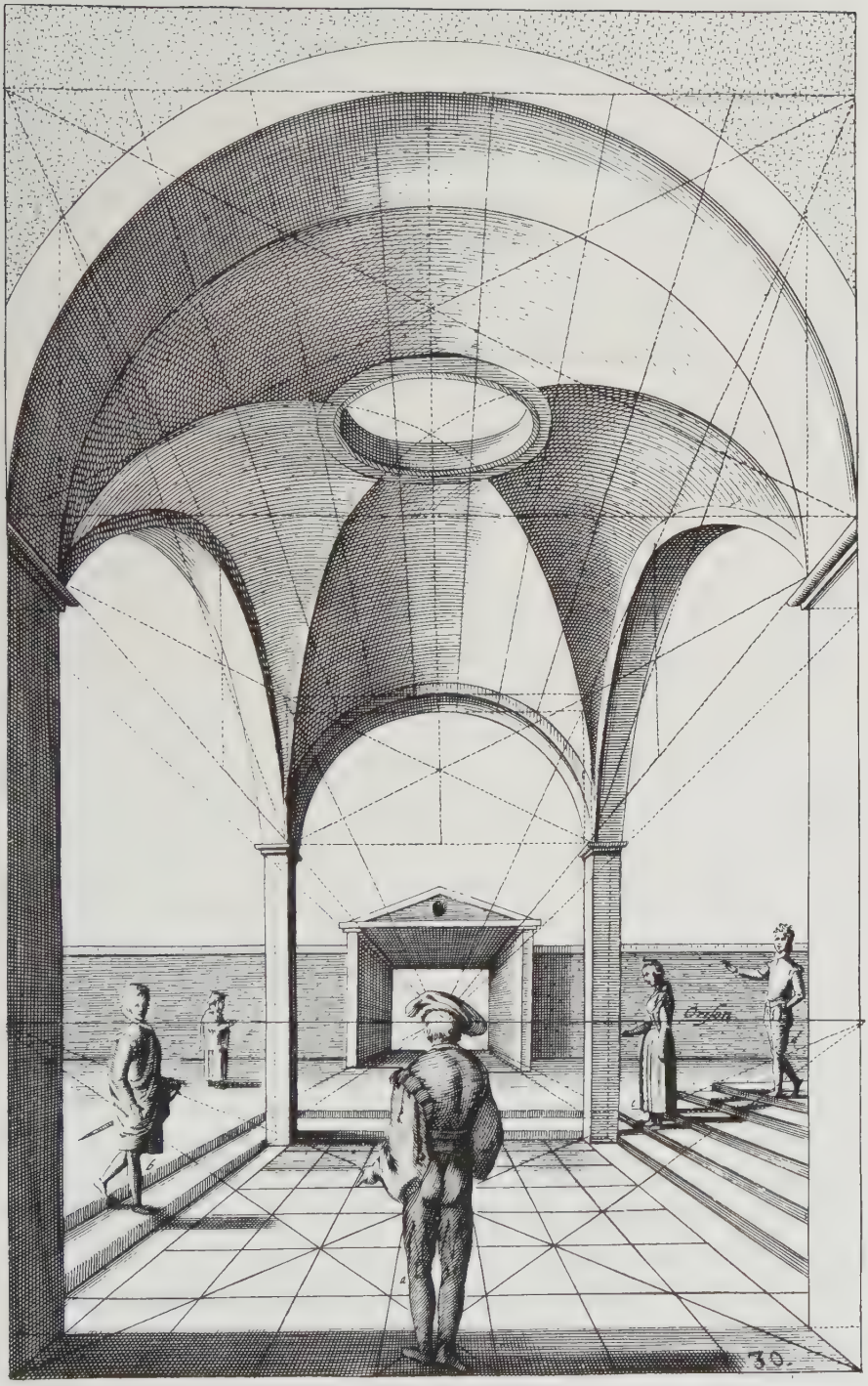


Figure 100: Jan de Vries, Perspectiva (1604), copper engraving no. 30.

To the notion of a window there also belongs a window frame. It "complements the claim of mathematical certitude" and cuts off the blurry area at the periphery of vision, making it not just an aesthetic boundary but also a measurable quantity.[63] It is no accident that the first frames for paintings were modeled on genuine window frames.[64]

Whereas a painting makes the gaze at the world explicit, at the same time it implies the location where the viewer is standing. A virtual law of Western art lies in this contradiction between inside and outside: The world is one that is viewed opening behind a symbolic window. Only then does the full cultural significance of the term "perspective" reveal itself. Only someone who is standing at a window or door can "see through" something. A window permits a viewer to be "here" with his body but to go "there" in a disembodied form—wherever his gaze can reach. This fact itself brings into play the "ocularcentrism" that has received so much criticism. While the eye overcomes the obstruction of the wall, it disembodies the observer who is standing at the window. With the motif of the window we have hit on a pivotal point in the "history" of the Western gaze. The relationship to the world is determined at the window. In his book on Leibniz, Gilles Deleuze speaks of the *scission* or "split" between interior and exterior that has affected Western thinking so strongly.[65] Since the early Renaissance the interior has represented the symbolic location of a subject (the ego), while the exterior world can be reached only in the gaze. The distant view *(Fernblick),* which still echoes in the German word *Fernsehen* (television), seeks the world beyond the window.

The situation of the window can be understood as an ontological securing of the gaze, which becomes its own image. In this sense the new panel painting served as a symbolic window. It assumes the presence of a subject who casts a centered glance at the world. The window also separates the public area from the private. The world outside the window is a different place, not the one where the subject is at home with himself. Descartes speaks of the "extended" *(extensa)* world of objects and appearances outside, but he no longer believes that it can be reached by the subject in the gaze. The window is both panel and opening, frame and distance. One can open and close it, hide behind a window, or be reflected in the glass of the windowpane. The glass used in picture frames has inherited the role of window; the thief who stole the *Mona Lisa* from the Louvre in 1911 left the glass and empty frame behind.

For a long time windows in private houses were essentially no larger than panel paintings, and so painted "windows" referred to genuine ones. In both instances the viewer was confined in an interior space while the world remained outside.

The interior was the location of the subject, the exterior the location of the world, from which the ego withdrew in order to observe it. This *experience of interiors* has no doubt affected the *self-experience* of the subject in Western culture significantly. In Arab culture we encounter a directly contrary understanding of windows (see p. 252). Furthermore in Asian culture it may be that different forms of dwellings prevented the development of a concept of the subject in the Western sense.[66] There, sliding windows and doors keep the relationship between interior and exterior open. Also, in this Eastern culture the European painting, with its window format, remained unknown until the nineteenth century. The format of a scroll that could be hung on a wall, and the way its images were ordered, offered no resemblance to the view out a window, which presumes that the observer is directly facing a wall, and much the same can be said of painted screens, since they could be folded and placed anywhere in a room as desired. Instead of opening a window to the outside world, in a manner of speaking they brought the outside world into the room.[67]

In his theory of architecture Alberti advised architects to relate the windows of a building to the gaze precisely, since "light is seen by the face, not by the feet."[68] In the tenth book of his work on architecture he writes, "The gaze remains fixed where it can find a quiet point, so to speak, where it can tarry."[69] This is the spot behind the window. The younger Filarete describes the painting *(quadro)* as an "imagined window" *(finta finestra)* that establishes the distances in the painted visual space. Only in such a view through a window is there an "analogy to sight."[70] The new type of painting serves the gaze as a symbolic window. We must distinguish here between idea and fact, however, for a window and a screen are not the same thing. A screen inserts itself in front of the eye, a window is open. Only window glass has this double reference. But a painting is only an imagined pane of glass. Alberti's mention of a semitransparent membrane *(velum)* or a veil is a compromise between window and screen.[71]

Is Alberti's window metaphor still valid when he applies it to narrative paintings, where physical space is of less concern than action and movement? Critics have usually failed to notice the context in which Alberti refers to the painting as "an open window." In fact he speaks of "an open window through which I look at the *historia*."[72] Hence we must take a moment here to consider the term *historia*. In the Italian version, he speaks in this same passage only of "an open window through which I look at what will be painted there," but in the next sentence he mentions that the painting will include human figures. One of the reasons why artists practiced perspective as a symbolic form was to create a stage for narrative

action. The figures of the narrative needed a place where they could encounter each other, that is, a space that was distinct from the physical space occupied by the observer. This matters because Alberti understood the term *historia* as not simply a story but rather as particular material presented in a theatrical manner. As the noblest form in which a painter can cast his work, a *historia* is neither merely epic narration nor a retelling of history but a theatrical situation such as exists between the stage and spectators.[73]

Paintings must affect viewers so strongly that they feel as if they are seeing living people suffering or in love. It was this maxim that cleared the way for European art to find its own particular form of "theatricality," as Diderot would later observe.[74] According to Alberti there must be at least one figure "who tells the spectators what is going on," who "either beckons them with his hand to look, or with ferocious expression and forbidding glance challenges them not to come near." Naturally it was a fiction that observers would "mourn with the mourners" or "laugh with those who laugh," but this fiction also described the spatial relationship between an observer and a picture. This is why Alberti says a genuine congruence must arise with the figures in a painting, similar to what exists between actors and audiences. The perspective painting becomes a stage here, on which a story is painted as if it were real.[75] Just as occurs today in movie theaters, painting at that time raised the curtain on an imaginary stage or on the stage of an imaginary theater, mobilizing the mimetic capacities that we develop as spectators. Stages and windows both serve the gaze, even if they do so in different ways. To end this small excursus, let me say that one can thus understand panel paintings both as windows and as stages. We can speak here of double representation in which painters objectified the gaze both times. Thus an isometry of depiction and gaze arose and became the fulcrum of the new perspective.

It is precisely in the metaphor of the window that perspective has a strikingly good claim to be called a symbolic form. We must add one further thought to this metaphor, however, for if perspective depicts a view from a window, this does not mean that it shows the window itself other than in the picture frame, because the window is only the location of the gaze. In other words, the window itself must be left out of the view, so that the observer forgets about it and his gaze can reach the outside without hindrance. The window merely presents the opportunity to direct one's gaze outside. One cannot include in one's gaze simultaneously both the window and the view from it. It is significant that representations of windows are found only in wall paintings or frescoes where the "view through a window" by itself is unsuitable. There are cases where painters have played with false windows,

but a spectator is not standing at them because his real location is in front of the wall with its panoramic view. At the Villa Farnesina in Rome, for example, Baldassare Peruzzi opens a fictitious view to the outside between painted columns. One appears to be looking at the surrounding quarter of Trastevere, as if there were suddenly an opening in the wall. The genuine topography in this case, incidentally, constitutes the crucial difference from the illusionistic paintings at Pompeii. In 1530 the duke of Gonzaga prevailed upon Giulio Romano to leave Rome for a large commission in Mantua; there the artist painted a fictitious stable in the Palazzo del Te, where the duke's favorite horses are portrayed in life size on an inner wall, as if in a real stable (Fig. 101). They seem especially lifelike and solid because behind them is depicted a background in which painted windows open onto a view of the landscape. The windows are every bit as illusory as the horses, and the same is true of the view through the windows. The whole design is an ironic commentary on the mania for windows in contemporary painting, rather like the way Parmigianino made fun of his colleagues' mania for mirrors in the self-portrait mentioned above (see Fig. 96).

Not until the seventeenth century did painters take a more distanced attitude and begin to cast doubt on the "view from a window." They promptly began to replace the view toward the outside with a view from outside looking in. The interior shuts out the outer world, since the residents remain inside, among themselves. Samuel van Hoogstraten, a virtuoso of painted illusions, even goes one step further. By painting a window as such and placing viewers in front of it rather than offering a window to them, van Hoogstraten turns things inside out. One must actually see on the wall the painting from 1653, now in Vienna, to experience this reversal of the window view (Fig. 102). We see from the outside a mostly closed casement window with crown or bull's-eye glass and the face of a stubborn-looking bearded man who has managed to push his head out one part of it. It looks as if he wants to force his whole body through the small opening, even though he could never manage to get out that way.[76] He has shoved his head forward to a point that only his gaze could actually reach. While the rest of his body remains invisible behind the window, the man with the fur hat has such a pleading expression that it looks as if he wants to call to those of us "outside" to come help him. The chipped and cracked stone slabs around the window intensify the effect of the scene: the man loses all distance to the world and thus also the orientation that the "view from a window" usually provides. The tiny bottle on the window ledge seems easier for us to reach than for the inhabitant of this imaginary house. Hoogstraten specialized in such effects. In this work he brilliantly re-

Figure 101: Giulio Romano, wall fresco (detail), Sala dei Cavalli, Palazzo del Te, Mantua (Mauro Ranzani Photography).

verses the meaning of the "window view," so to speak. We ourselves have lost our place at the window, but an observer trapped inside is trying futilely to make contact with us.

In other works the same artist counterfeited the images of the camera obscura. One painting, which now hangs in the Louvre, has us looking through an open door and across a passageway into another room where a picture by a colleague is hanging on the wall (Fig. 103). The observer is thus assigned a place at an open door leading to the passageway. We have a full view neither of the corridor nor of the room on the other side of it. Since we are in the interior of the house, we lose

Figure 103: Samuel van Hoogstraten, Interior, 1658, Louvre, Paris (Bridgeman Art Library).

Figure 102: Samuel van Hoogstraten, Window, 1653 (Kunsthistorisches Museum, Vienna).

the window as the location of the subject. As long as the view was out the window artists could not depict the interior, but now the gaze has turned away from the window. If the view from the window is "out there," then one's awareness is there, too. But if the gaze remains inside the room it has to turn away from the window. The option for the interior suggests a crisis of the window view, a crisis that also undermines the idea of the subject. In an interior there is no privileged location, nor is there a framed view. The subject remains with himself, without sending the gaze outward.

Interiors are a favorite subject in the work of Jan Vermeer. The windows let in light but do not expose the outside to the gaze, an intentional contradiction characteristic of Vermeer's art in general. Thus the young woman in a painting that now hangs in the Gemäldegalerie in Berlin *(Woman with a Pearl Necklace)* is looking into a mirror hanging directly next to a window, taking no notice of the window or the outside world. She is with herself in a double sense, since she is looking at herself in a mirror. In other paintings by Vermeer people are standing at an open window but reading a letter instead of looking outside.[77]

One of Descartes's topics was the distance between human beings and the exterior world. Because the senses are lost in a world of illusions, as he writes in the *Optics,* our perceptions are entirely deceptive, for "it is the mind which sees, not the eye."[78] In his *Discourse on Method* he describes how he "remained all day alone in a heated room" and he pursued his own thoughts before continuing on his travels to see the world.[79] Descartes's *Meditations on First Philosophy* explicitly exposes the "window view" as something other than what it seems: "I . . . happened to glance out of the window at people walking along the street. Using the customary expression, I say that I 'see' them . . . But what do I actually see other than hats and coats, which could be covering automata? But I judge that they are people. And therefore what I thought I saw with my eyes, I in fact grasp only by the faculty of judging that is in my mind."[80] What could anyone actually experience about the world by standing at a window? Descartes, who saw visual processing as a blindly automatic operation, mistrusted knowledge and confirmation of a self-image gained through the eye.

During the baroque era the crisis of the "window view" reached a peak in Leibniz's *Monadology:* "The monads have no windows through which something can enter or leave." They are organized solely according to an inner principle and their perception is simply the "inner state of the monad representing external things." What could the gaze achieve in such a case? The "many different universes" were, after all "only perspectives of a single one, corresponding to the different points of

each monad."[81] As Gilles Deleuze observes, the monad is autonomy of the interior, of an inner world without an outer world.[82] Attempts to replace the metaphor of the window led in the baroque period to a virtual flight from the window; in retrospect this phenomenon emphasizes in its own way the unique boom that the window metaphor had experienced before.

The window view had become autonomous and detached itself from the human body. It removed both the window itself and the body of the person looking out, for otherwise the observer would have seen himself from the back and have had to include this figure in the painting. German romantic art produced a complete inversion of the window view. When Caspar David Friedrich reintroduced the motif of the window, he consistently added the figure looking out, viewed from the rear. In so doing he split the gaze into two, another person's as well as our own, so that we are looking at someone looking out the window. Wolfgang Kemp sees in this a desire to "place inner vision above the outer kind," but the gaze remains divided.[83] We as viewers of the painting are standing in an interior after all, while another person is responsible for "looking outside." If we look back from here at the long history of the window view, it becomes all the easier to recognize how much it had been a symbol for the conscious subject and how it had illustrated his gaze and his view. Perspective as a symbolic form had concentrated on the idea of representing the subject in his gaze.

Blickwechsel: The *Mashrabiyya* as a Symbolic Form

A window through which the gaze can "see," as it occurs in the idea of perspective, is completely opposite to the way a window is conceived in Arab-Islamic culture. The shift of focus that I propose once more may strike readers as particularly abrupt, even though it is connected to the topic of the window and its central position in the visual culture of the Renaissance: Windows and the view from them are inseparably linked in Western culture. If we shift our focus to Arab culture, however, this connection is not made. Yet simply establishing that both the window view and the Florentine invention of perspective "are lacking" in the other culture is not sufficient for our purposes here. It is more important to consider why that is so and what were the dominant premises in the process of organizing the gaze and establishing social control over it. Naturally, windows exist in

the Arab world, as they do in every culture, but it is worth asking some questions about how they are different. More is not possible; it must be enough to identify characteristics that enable us to formulate questions of the kind we have chosen for the eyes, windows, and the horizon in the modern period in the West. The answers must be left to experts who know Islamic culture well enough to develop the semantic spectrum for which the window, with its staging or "orchestration" of light, counts as a symbol. If the comparative method proposed here is to be meaningful, it must contribute to a better understanding of each of the two cultures on its own, providing an occasion for a dialogue that is still somewhat unfamiliar. It should be added that the "new Narcissus," who creates himself in pictures, possesses sufficient powers of discrimination to lead the excursion into another culture—where he would have broken taboos immediately—in the right direction.

Let us turn once more to the window view in the early Renaissance to establish a point of departure for the following thought: The Western gaze is directed toward pictures that it seeks as if looking through a window. An instructive misunderstanding occurred when, about the year 1500, a German painter portrayed two Arabs or Turks at a window, looking out at the world (Fig. 104). In the Pfullendorf Altar (now in a museum in Stuttgart) they represent two prophets from the Old Testament; they are wearing Eastern turbans but showing themselves at an open window as is typical for Western culture. The world becomes visible in a gaze that is directed from indoors at the outside. The connection between interior and exterior is direct and open, since it applies only to the gaze and not to the body of the person gazing. That body remains "inside," while he regards the world in its quality as "exterior world" and lays claim to it in his gaze.

In the Islamic world a *screen* is built at this threshold that became a focus of artistic energy. The screen is porous, but not for the gaze—at least not in principle; rather, it is porous for *light,* a shift that also reverses the direction between inside and outside. This observation is connected to the topic of measuring light in contrast to measuring the gaze, which was discussed earlier (see pp. 23–26). Windows are of course always there to bring daylight into an interior space, but here the aim is different. In Arabic living spaces we find a "staging" or "orchestration" of light that carries its own symbolism. The light always originates outside, but here it is directed inside in a particular way, where it draws the gaze of those inhabiting the space without their having to look outside. It is the *reflection* of the light that is staged, through the angle of incidence and the geometry of the screen.

As a rule, windows are screened to mark the separation between inside and

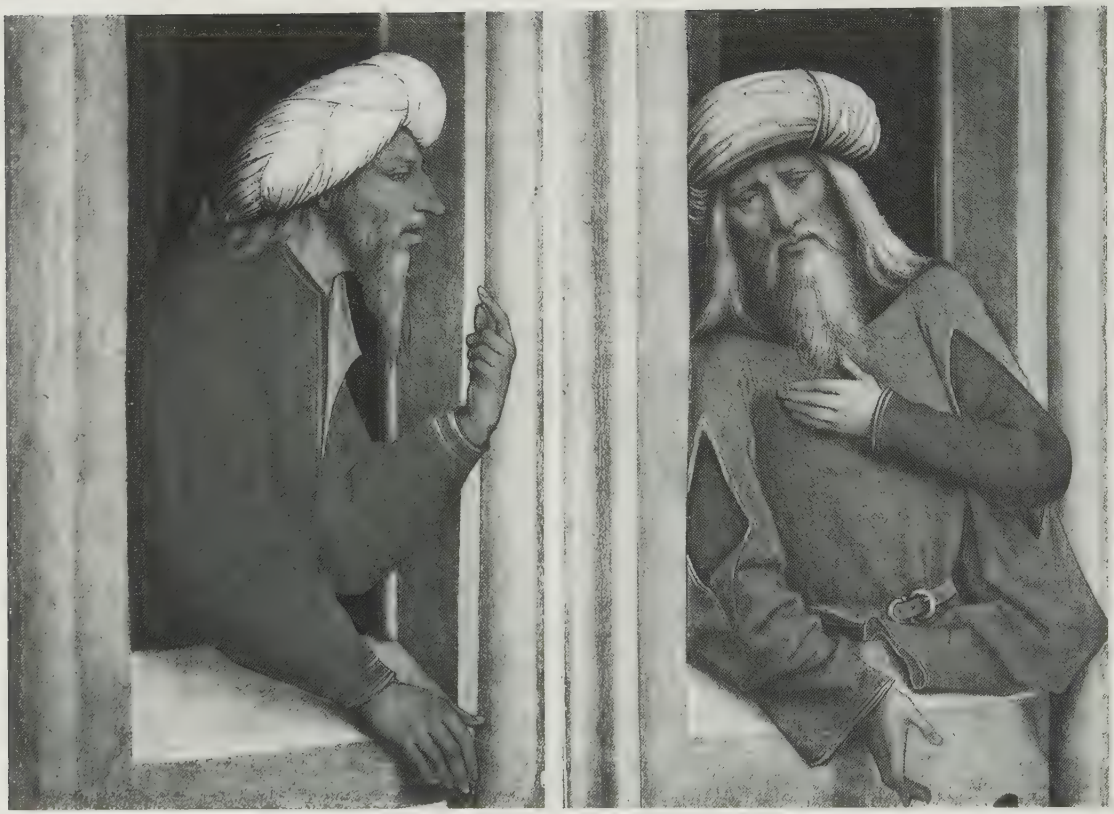


Figure 104: Master of the Pfullendorf Altar, Two Prophets, end of fifteenth century (Staatsgalerie, Stuttgart).

outside, that is, the dividing line between the private and public spheres. The inhabitants are able to observe the street without being observed themselves. The light enters the interior as if through a dense filter, and inside, the screen creates a pattern of light and shadow that moves across the room as the sun passes overhead in the course of a day. As we have seen, Alhazen's experiments with the camera obscura were also concerned with reflected light (see p. 95). As Alhazen understood the nature of light, only its rays travel through space, and thus the geometric screens add a secondary order of rays that makes the light measurable and draws the gaze. The gaze registers a geometric pattern that is formed by both the window screen and the light, operating together. If one wanted to speak of perspective, then in terms of Arab optics it would be a perspective of light that crosses the barrier of the window to the inside and is regulated there by the geometry of the window decoration; this process does not produce "pictures" in our sense. At the same time the light seems purer and more abstract than in the out-

side world, where it is mixed with colors and carries the forms of objects to the eye. In Arab window screens the alliance between rays of light and visual rays is broken up, and in the reflections they create pure light, returning it to its original nature.

If perspective is understood as a symbolic form, then the lack of perspective would, by rights, also be regarded as a symbolic form. Yet to speak of a "lack" of perspective implies that perspective represents a fundamental condition that is either present or "missing." In fact it is a convention, based on a construction guided by intentions and expectations that are easily described. Furthermore even an anti-perspective would have to be based on the specific form of perspective that was developed in the early Renaissance. Studying perspective as a cultural or symbolic form is meaningful only if the goal is to give equal acceptance to other forms and rules for guiding the eyes. In Islam, light could be understood as a symbolic form. It is not produced in the human gaze but created through decoration that filters and regulates light. Windows with their geometry serve to stage light itself as a symbolic form.

The Egyptian architect Hassan Fathy, a representative of Islamic modernism, spoke about such a symbolic form in discussing the *mashrabiyya.* This was an old style of window that was used to decorate balconies as well. It has a wooden latticework screen whose decoration influenced the term that soon came to be used for windows. This is significant, since here the accent was placed on the *window that screens out light,* rather than the *window as an opening.* Fathy wanted to revive this form of window—to which he even devoted a literary work of his own, titled "Fable of the Mashrabiyya"—in the modern architecture of the post–World War II period.[84] In that tale he describes how such window screens prevent blinding light from entering the room by mixing it with shade, and how they break up the surface of the walls with ever-changing patterns as the day goes by. The screen pattern must be dense and divided into many small sections up to eye level, he writes; above that it can become more porous and open so as to admit more light. A drama of light is played out through this screen, just as in the camera obscura. In addition to screening people in the room from view, such windows have the further advantage of promoting the circulation of air.

During an interview in 1974 Fathy observed that Arab architecture is directed from the inside toward the outside; it is an architecture of interior spaces and not of walls.[85] It is just as evident, however, that the interior spaces are dominated by the light that filters into them from outside. In a residential housing development near Luxor that Fathy built of mud bricks, he used decorated window screens to

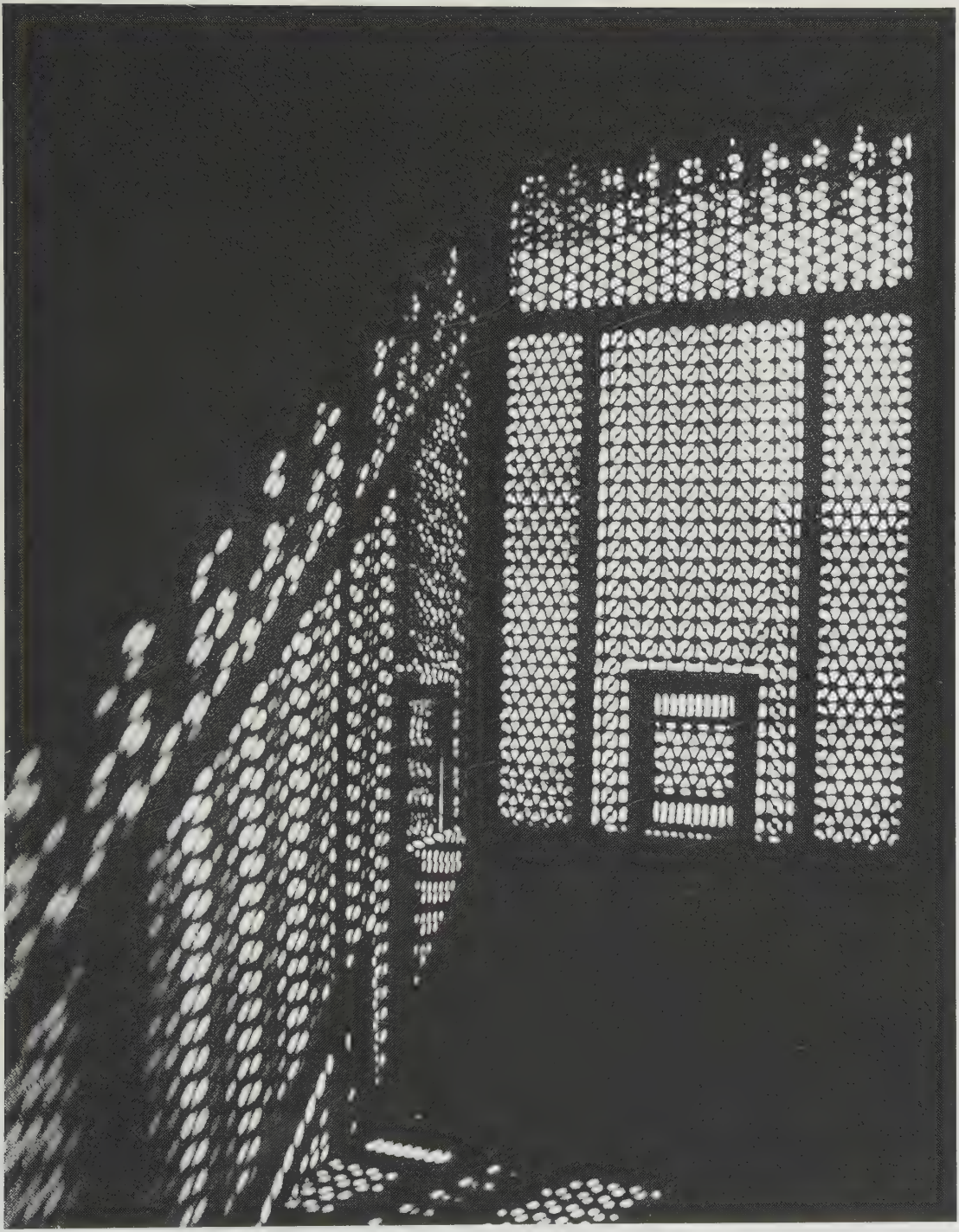
develop a lively pattern of light and shadow as light enters through a window and slowly moves across the walls and floor at a constantly changing angle to the window and other architectural elements (Fig. 105).[86] As this happens the light itself becomes a topic of the geometry, freeing itself from the material medium of its transmission, the screen, and circulating in the room in changing refraction and at different angles. This is precisely what "symbolic form" means. To put it in paradoxical and yet accurate terms, one could say that the windows are directed toward the interior instead of drawing the gaze toward the outside. They are windows that serve light rather than the gaze, for by means of their screens they give the light a form that materializes only in an interior, a form that needs the dark interior space as a contrasting backdrop. The built space recedes and becomes a stage for which lighting has been designed. Lighting design has a special meaning here, for light as a cosmic force "makes an entry," so to speak, as it runs its course through the interior space in a daily rhythm.

Figure 105: Hassan Fathy, interior of a house in Gourna near Luxor, Egypt, ca. 1950 (James Steele / MIT Press).

This practice reaches far back in the history of Islamic architecture. One consummate example can be found in a tomb built south of New Delhi in Agra, in the year 1628. The pattern, carried out here in marble, consists entirely of the strict geometry of circles and rays that otherwise appears on two-dimensional surfaces; in this instance, however, it combines with the light to form a double pattern that can be read in two ways (Fig. 106).

The idea of the *mashrabiyya* also influenced the domestic architecture of the rural Arab population until modern times. In 1980 the photographer Ursula Schulz-Dornburg created a large cycle of images documenting a cultural landscape in Mesopotamia that was in the process of disappearing; among these photographs is one of an Iraqi farmhouse, showing a dark interior from which the Tigris River can be seen flowing by (Fig. 107). Above the five-sided doorway is a window of the same size and shape that illuminates the room and draws our gaze to the light behind the simple wickerwork pattern. The window has a practical function but is symbolic at the same time. Only the doorway opens a view to the outdoors and allows inhabitants to see the changing images of the outside world. The window, which serves only to provide light in the room, purifies the view of all images and directs the gaze to the entry of pure light from behind the dark framework of woven geometry.

An exhibition that took place in London in 2003 and was devoted to the topic of the veil included photographs of a special kind by the artist Henna Nadeem. They capture different views of the neighborhood of Brick Lane in London, where she lives, through the filter of a kind of *mashrabiyya* (Fig. 108). The screens



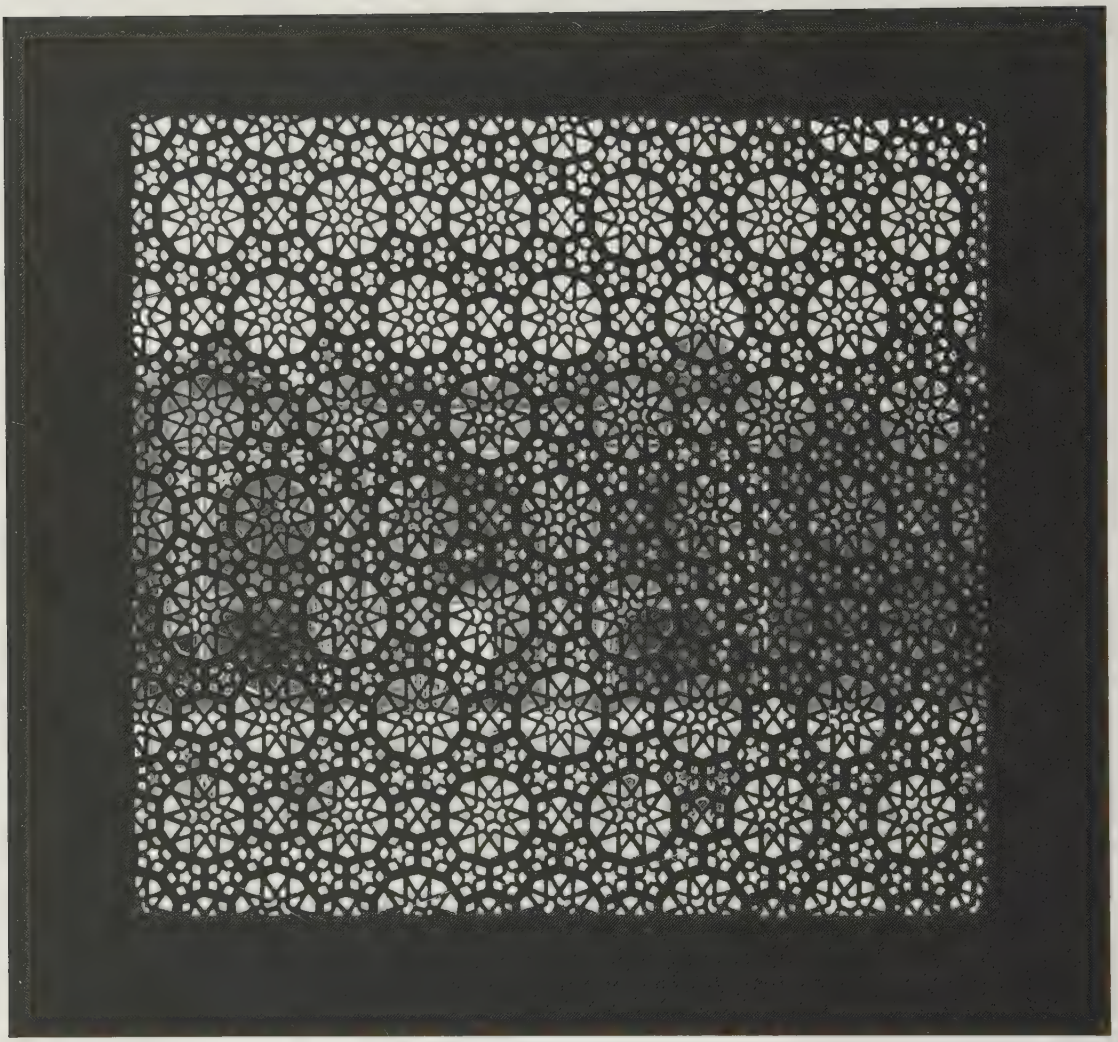


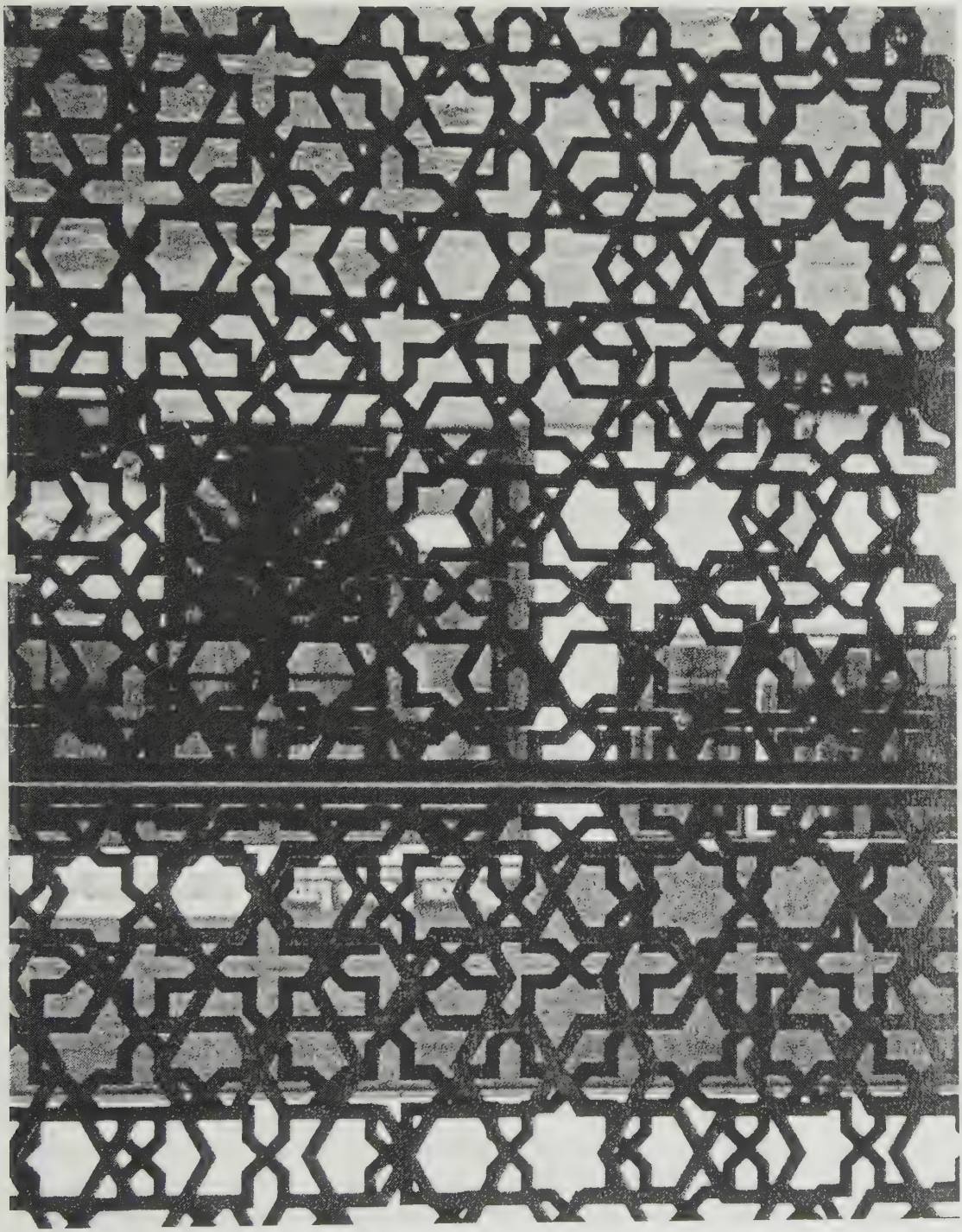
Figure 106: Window screen, tomb of I'timad al-Daula, Agra, 1628 (courtesy of Oleg Grabar).

remove the streets and the world that is portrayed from our direct gaze. Our eyes are drawn to the screen in the foreground, where the geometric figures make a stronger impression than the unclear and blurry forms behind it. In this way the artist lays a veil over the streets of London, which she sees in a certain sense through the eyes of her cultural heritage. Veils and screens allude to each other here. At the same time, this contemporary artistic approach includes a memory of a visual culture in which geometry, in a dialogue with light, had a stronger presence than the random appearance of things.[87]

For Fathy, the modernist in Egyptian architecture, every culture represents a unique reaction of people to their surroundings. It bears witness to the continuing effort to find new answers to our physical needs and spiritual desires.[88] The sole intention of our shift of focus from the Western type of window to the *mashrabiyya* is to understand the particular natures of both cultures rather than to emphasize yet again what separates them. Making distinctions offers opportunities for interpretation, but it requires that one not consider Western culture to be universal and assign a merely local status to all other cultures. From this point of view the Western type of window is just as much a local phenomenon. To interpret its meaning we are aided by Renaissance painting, in which it found its emblem. That kind of painting made the view from a window, the gaze behind a window, its key theme. It is the curious gaze that seeks images in the world. By contrast the *mashrabiyya* tames the gaze and purifies it of all sensuous external images through its strict geometry of interior light. In the two cultures, outside and inside stand in a different relationship to each other, just as the gaze and light do. It is obvious that behind these relationships stand two different worldviews, which also assign different roles to the observing subject. In one case the subject becomes active in his or her gaze, while in the other the subject experiences light —that is to say, a suprapersonal force—as a cosmic drama. Perspective, together with the metaphor of the window, is a symbolic form in Western culture, but in the same sense the *mashrabiyya,* which takes the appearance of light as its theme, is a symbolic form in Arab culture.

Figure 107: Ursula Schulz-Dornburg, House on the Tigris, Iraq, photograph from the exhibition Verschwundene Landschaften (Lost Landscapes) 1980/2002 (Ursula Schulz-Dornburg).

Figure 108: Henna Nadeem, window screen (detail of a photograph), 1997 (Henna Nadeem).



Conclusion

Comparing the Gaze in Different Cultures

Western art of the Renaissance awakened the expectation that art would represent the gaze of those who looked at it and give that gaze a visible existence. The alliance of gaze and picture, in the sense that the gaze becomes a picture or enters a picture, reveals its true features and local (that is, Western) character only in a comparative project introducing another culture. Pictures always address a gaze, without which they would lose all meaning. Yet this does not mean that pictures also depict that very gaze—that they hand the initiative back to the viewer, so to speak. In such instances they relegate the narrative or moral lesson to second place, in order to hold a mirror up to the viewer and his own view of the world. An "iconic gaze," as Western perspective presents it, is a gaze that has become a picture. In the same sense, an "iconology of the gaze" is nothing other than a term for a history of pictures that deals with both the history of the collective and individual gaze and the social change they have undergone. Without such a history of pictures, we could only speculate about the gaze in historical times. The people with such a look are no longer living, but the old paintings were created for their gaze.

Mirrors and windows offer symbolic occasions for gazing at the world. The use of the mirror was guided by cultural codes, and this applies even more to the window, which was a genuinely important topic in the West both as the site of a subjective gaze and as a model for picturing the world. In the West, mirrors and windows awakened an impulse in individuals to keep tabs on the world with their own gaze and to enhance it with scientific instruments. In the act of perception the gaze became sovereign over the world, at least in theory. The visual drive is present in all human beings, of course, but societies and cultures do not make the same use of it. Mirrors and windows have steered both the production and the perception of pictures in Western culture. Terms like "scopophilia" and "scopophobia" not only denote general attitudes that determine the visual realm but also have entirely different meanings in individual cultures.[1]

The Western gaze is specific in the sense that it was practiced within a distinct

history of its own. The many discourses in which it is a theme do not in fact apply to a gaze with universal validity but rather to one with local rules, liberties, or taboos. It makes sense to speak of a "scopic" culture only if collective norms for the gaze are laid down that can be explained in historical terms. Only by identifying historical conventions can we speak of a history of the gaze. In an aristocratic setting, different rules applied to the gaze than in a bourgeois society, and since the disintegration of the latter, still other rules have come into play. In the era of mass media and its successor, the digital age, visual habits have changed yet again. Pictures—wherever they exist in the Western sense—give expression to changes in the collective gaze.[2] They may court the eye or irritate it, celebrate or humiliate it. Historically, pictures once halted the sensorimotor mechanism of our restless eyes and gave permanence to a single moment, while nowadays one can say, to put it politely, that we encounter moving pictures or live images as competitors of our own gaze.

That a Western gaze exists is tacitly recognized in the fact that people speak of its history, for the different eras that receive the most mention are usually limited to Western history. Michel Foucault, for instance, investigated the clinical gaze and anonymous surveillance (not only of prisoners) in the period around 1800.[3] Christian Metz has spoken of the "scopic regime" of the cinema, as if cinema represented a self-contained world.[4] Other scholars have discussed scopic regimes in eras such as the baroque (Christine Buci-Glucksmann) or the nineteenth century (Jonathan Crary).[5] In his famous study on photography Roland Barthes called for a "history of the gaze," but had in mind solely the medium to which his text was devoted.[6]

The history or iconology of the gaze is not synonymous with a history of perception, however, even though the titles of many studies neglect this distinction.[7] Although we use the same eyes to gaze at and perceive the world, the gaze is first and foremost the expression of an individual person, and it is also a social act. If we transfer this distinction to the history of pictures, then it becomes apparent that pictures have a twofold function: either they serve perception and its codes, or they symbolically represent the observer (and his historical relationship to the world). The German terms *Vorstellung* (imagination; mental image, idea) and *Darstellung* (depiction, portrayal), which both figure in English as "representation" and in French as *représentation,* play a complementary role. In somewhat oversimplified terms, the pictures that we create of the world arise *in der Vorstellung,* that is, in the imagination: They are mental images that, as we have seen, also have a defined meaning in Arab culture, despite what critics of representation

have claimed. In the case of *Darstellung,* by contrast, we mostly think of material images that we use to check or monitor our *Vorstellung.* With modern neuroscience we can now distinguish an *internal representation,* in the world of our imagination, from an *external representation,* in which the praxis of making pictures takes place.[8] This makes all the more important the close reciprocal relationship between the *Vorstellung* (imagination), as the domain of internal images, and *Darstellung* (depiction), as the locus of public images.

Languages have developed terms for the gaze that possess significance precisely because of their differences. The French term *regard* invites us to associate it with *prendre garde,* which means to be careful, to be on one's guard. In his book on the portrait Jean-Luc Nancy relates *regarder,* to look, to *garder* and *surveiller,* to guard.[9] Michel de Certeau speaks of an "antinomy" existing between seeing and looking.[10] Another gaze takes away our *vue.* In English, expressions such as "regard" and "regardful" come close to the meanings of "watch" and "watch out," that is, acts of self-censorship and behaviors that go beyond the neutral "look out." Kaja Silverman and Martin Jay distinguish between the meanings of "gaze" and "look," just as Norman Bryson distinguishes the "prolonged gaze" from the "fleeting glance."[11] In this labyrinth, metaphors conceptualize the gaze very differently. In the German language, which employs the term *Blick* (gaze, glance, view, vista) in as general as sense as *Bild* (picture, image), the word *Blick* is derived from *Blitz* (flash of lightning; thunderbolt), according to Jacob and Wilhelm Grimm's German dictionary. In German it is still common today to speak of a gaze "striking" someone.

The gaze cannot be defined in physiological terms, nor does it depend solely on the perceptual techniques that it uses. In the gaze there lies an act of self-assertion that leads us to the subject who may assault another person with his gaze or be assaulted by another's gaze. Recently, though, the subject has fallen victim to a fashionable deconstruction. Mechanisms in the operation of human instincts are made responsible for the wishes or the inhibitions of the gaze. Yet we are on a wild-goose chase if we disregard the history in which the topic of the gaze is enmeshed. The gaze is practiced collectively in every society, although every individual believes it to be his or her own. Just as members of different races are recognizable by their posture or the way they dance, they also announce their membership in a particular culture by their gaze. Visual fetishism, too, has been culturally specific in this sense. The gaze is simultaneously a motor for perception and a brake on it. The gaze and the eye are inseparably connected with one another, whether as accomplices or opponents. The discourse on gender has de-

voted an appreciable amount of attention to the topic of the gaze, but it reduces the exercise of power through the gaze, to which everyone is constantly exposed, to one specific situation.[12]

In cultural terms an aversion to pictures is usually an indication of taboos imposed on the gaze. This conflict became evident in ethnologists' field research, when they pointed their cameras at various local societies. Their desire to take photographs sometimes violated local customs regarding the gaze or interfered with the intricate rules governing it. In his critique of Norbert Elias's history of the "civilizing process," Hans Peter Duerr has stressed the importance of self-control with regard to the gaze, which he regards as part of efforts in so-called primitive societies to regulate basic drives.[13] Sanctions were imposed on the sphere of intimacy when "the eyes strayed to where they were not welcome." Indirect gazes and invisible boundaries to the gaze ("phantom walls") gave rise to private zones in public space, where people treated one another as if they were not present.

The veil, which today is becoming a symbol for the suppression of women in Islamic societies, was once part of a visual culture with fine gradations that imposed duties on both sexes and regulated the boundary between private and public space. Women veiled themselves, and men were required to turn their eyes away. In his text on the "averted look," Hamid Naficy ascribes to the veil a significance similar to that of walls and words, noting that "walls, words and veils mark, mask, separate and confine both women and men." A man was obligated to announce his presence aloud, and the voice was "veiled" in its turn by formal language. This kind of communication produced a system in which the gaze controlled and was controlled in equal measure.[14]

The emphatically nonperspective miniatures of Iran discussed by Naficy also divide the space of a single narrative into separate layers and zones, hermetically sealing them off from one another and always assigning them to particular actors in the scene, so that they remain inaccessible to others. And the window screens of the *mashrabiyya* serve as barriers to the gaze, dividing indoors and outdoors so strictly that only light can pass through (see p. 252). This aesthetic appears to reflect social controls on the gaze that developed over long periods of time. It culminates where the aim is not so much to create barriers for the gaze as to encode the sensory world through the use of script and geometry, and to impose a filter between the world and the gaze, which is thereby tamed and cleansed of the senses and their images (see p. 111). The geometry that placed a screen around the gaze in Arab art is of a fundamentally different kind than the geometry used to

construct perspective painting in the West. Hence it is precisely the way pictures are made—understood as a social practice—that can shed light on Western culture and its specific qualities, permitting us to examine them critically. So far, few have attempted to address this, perhaps because of the risks involved in crossing the boundaries of disciplines in which the experts on both sides tend to become defensive.

Two comparative studies can shed light on the task that I set myself, although they happen to deal with East Asian culture. Norman Bryson has written an essay titled "The gaze in the Expanded Field," and François Jullien has investigated the very different nature of pictures in Chinese art, in which the Western relationship to an object being depicted is not intended.[15] Bryson takes as his point of departure the controversy over the Western concept of the subject, who is defined, above all, by an object of which his gaze takes possession. The dissolution of visual boundaries in East Asian culture removes both the subject and his gaze from a fixed and secure position. According to Bryson, Japanese philosophers have always been critical of Western intellectual efforts to define a subject by relating it to an object seen and desired. In a space without limits, which is designated as "blankness," or *sunyata* in Japanese, all individual objects lose their firm existence too, so that the need for focus in the possessive gaze of the Western type disappears. A viewer who loses a frame for his gaze and is drawn into the continuous flow of sensory phenomena no longer behaves like an independent observer and can most certainly not be taken as the focus of perception.

Old Chinese scrolls demonstrated the flow of constantly changing views in one and the same work of art. The viewer, who had to open and unroll such scrolls himself, could allow his gaze to wander from one view to the next without having to find a mandatory focus, as with individual framed paintings. Control over the object is needed in order to individualize a gaze. As François Jullien writes, in East Asian art a form and visibility per se could be regarded as only a phase in the constantly changing state of objects. In the Western gaze, by contrast, Jullien sees the core of representation in the negotiation of the gaze between subject and object, for only mimesis can produce for the viewer the object that the Western gaze craves. That alone limits both representation and viewing to realism, which is still being cynically counterfeited in contemporary Chinese art.

All the same, an excursus into East Asian art cannot provide a model for the task of undertaking a cultural comparison of the gaze between the worlds of the West and the Middle East, since in the Far East we remain in the domain of representational depiction that separates the West from the Middle East.

Afterword

When I gave a series of lectures on the "history of the gaze" at the Collège de France in Paris in the spring of 2003, I did not foresee that they would lead to the subject of this book. It was necessary to change course before I could address the fundamental issue of images and the gaze and combine it with a shift of focus so as to include two cultures. I was prompted to undertake this change of course during a conference in Morocco hosted by the Heinrich Böll Foundation. The first results were presented in a Thyssen Lecture at Humboldt University of Berlin, in February 2006. I would like to thank Gottfried Boehm, Horst Bredekamp, and the Fritz Thyssen Foundation for this invitation, which led to further discussion and new questions. The acid test arrived in September 2007 at a congress of the Academia Europaea in Toledo, Spain, where I received encouragement from the mathematicians Ricardo Moreno Castillo, who had just published a book on Alhazen, and José Maria Montesinos. In December 2007 I was able to speak on the topic at a conference of scholars of Islam and the history of science, including George Saliba and Claus-Peter Haase, which took place at the Berlin University of the Arts. It was organized by Siegfried Zielinski in the framework of his variantology project, and I am greatly indebted to him for this invitation and his ongoing encouragement.

I could not have tackled the subject without the advice and support of scholars of Islam, including Almir Ibric (Vienna), Silvia Naef (Geneva), Alia Rayyan (Ramallah), and especially Oleg Grabar (Princeton). I am grateful to Silvia Horsch and Sasha Dehghani of the Center for Literary Research in Berlin for their assistance and also to Wendy Shaw (Bern) and her research on the late Ottoman Empire. Fuat Sezgin and his team at the Frankfurt Institute for the History of Arab-Islamic Science provided much helpful support. The article by Peter Lu and Paul Steinhardt in *Science* (February 23, 2007) has given a new dimension to the topic of mathematics and art in the Arab world. I am most greatly indebted to Abdulhamid I. Sabra (Harvard), who pointed the way for me with regard to method and

terminology with his critical edition and English translation of Alhazen's chief work, the *Optics*. Of similar import for me was the monumental work on the Topkapi scroll by Gülru Necipoğlu (Harvard), published by the Getty Foundation, since it provides a new basis for research on geometry in Islamic art. In this context I would like to mention that John Onians (University of East Anglia) devoted an entire chapter to Alhazen in the first volume of his *Neuroarthistory*. Material from my work on Biagio Pelacani's concept of space previously appeared in the Festschrift for Peter Sloterdijk in the summer of 2007.

As the introduction to this book makes clear, in studying the subject of the gaze in different cultures I am indebted both to the work of Norman Bryson and to a book by the mathematician Brian Rotman, who as a reader of Bryson's work first related the vanishing point in art to the introduction of the Arabic zero in Western mathematics. Werner Hofmann's research on the relationship between modern art and the pre-perspective painting of the Middle Ages opened my eyes to the larger context in which my topic is located. I thank Gerhard Wolf, whose book *Schleier und Spiegel* (Veil and Mirror) provided a most helpful orientation in Renaissance studies, for his invitation to discuss my topic in Florence. I received advice and useful criticism from many friends and colleagues, of whom I can name only a few here: Klaus Krüger (Berlin), Friederike Wille (Frankfurt), Christiane Kruse (Marburg), whose media anthropology brought the topic of the new Narcissus to the fore, and further Sigrid Weigel (Berlin), Annette Hoffmann (Florence), Martin Schulz (Karlsruhe), Almut S. Bruckstein (Berlin), Ecke Bonk (Karlsruhe), and Peter Weibel (Karlsruhe). I owe the suggestion to review Erwin Panofsky's work to Gertrud Koch at the International Research Center for Cultural Studies in Vienna. Kei Müller-Jensen (Karlsruhe) provided a critical reading and much useful advice from an ophthalmologist's viewpoint. Sergius Kodera (Vienna) introduced me to the ideas of Leone Ebreo. Candida Höfer and Ursula Schulz-Dornburg each graciously permitted me to reproduce one of their photographs. Hanns Kunitzberger (Vienna), Helga Kaiser-Minn (Hemsbach), and Alexander Polzig all read parts of the work in progress and urged me on when my spirits were flagging. I have dedicated the book to Andrea Buddensieg, who offered support in all phases of the project and expanded my gaze on our trips together.

My German publisher, C. H. Beck, offered me feedback and support with this book, as with others before it, and provided inspiration as I was concluding the writing. Detlef Felken took great interest in the book, and I recall the lively con-

versations in which we came up with a title for it. I want to thank Ulrich Nolte and Beate Sander for their contributions to the project, and Jörg Alt for the great care he took with the layout. Finally I am most grateful to my editor, Stefanie Hölscher, whose commitment went far beyond the norm, for encouraging an author with self-doubt and making this book possible.

Notes
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Notes

Introduction

1 George Saliba, *Islamic Science and the Making of the European Renaissance* (Cambridge, Mass.: MIT Press, 2007).
2 See Jan-Pieter Hogendijk and Abdelhamid I. Sabra, eds., *The Enterprise of Science in Islam* (Cambridge, Mass.: MIT Press, 2003).
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4 Régis Debray, *Un mythe contemporain: Le dialogue des civilisations* (Paris: CNRS, 2007).
5 Ilija Trojanow and Ranjit Hoskote, *Kampfabsage: Kulturen bekämpfen sich nicht—sie fliessen zusammen* ["Renouncing Battle: Cultures Don't Wage War against Each Other, They Flow Together"], translated from the English manuscript by Heike Schlatterer (Munich: Blessing, 2007).
6 Panofsky's influential article was first published under the title "Die Perspektive als symbolische Form," in *Vorträge der Bibliothek Warburg,* 1924–25, pp. 258–330. For an English translation see Erwin Panofsky, *Perspective as Symbolic Form,* trans. Christopher Wood (New York: Zone Books, 1991).
7 Norman Bryson, *Vision and Painting: The Logic of the Gaze* (New Haven: Yale University Press, 1983).
8 Brian Rotman, *Signifying Nothing: The Semiotics of Zero* (Stanford: Stanford University Press, 1987).
9 Ibid., pp. 1, 3–4, 25.
10 Ibid., p. 19.
11 Dirk Baecker, introduction to *Die Null und das Nichts: Eine Semiotik des Nullpunkts,* the German edition of Rotman, *Signifying Nothing* (Berlin: Kadmos, 2000), p. 11.
12 Rotman, *Signifying Nothing,* p. 7.
13 Alhazen, *The Optics of Ibn al-Haytham, Books I–III: On Direct Vision,* trans., A. I. Sabra (London: Warburg Institute, University of London, 1989), vol. 1, p. 71.

1. Perspective as a Question of Images

1 A selection of literature on perspective: Erwin Panofsky, *Perspective as Symbolic Form,* trans. Christopher Wood (New York: Zone Books, 1991); John White, *The Birth and Rebirth of Pictorial Space* (London: Faber and Faber, 1957; 3rd ed. Cambridge, Mass.: Harvard University Press, 1987); Samuel Y. Edgerton, Jr., *The Renaissance Rediscovery of Linear Perspective* (New York: Basic Books, 1975); Hubert Damisch, *The Origin of Perspective,* trans. John Goodman (Cambridge, Mass.: MIT Press, 1994); Martin Kemp, *The Science of Art: Optical Themes in Western Art* (New Haven: Yale University Press, 1990); James Elkins, *The Poetics of Perspective* (Ithaca: Cornell University Press, 1994); Thomas Frangenberg, *Der Betrachter: Studien zur florentinischen Kunstliteratur des 16. Jahrhunderts* (Berlin: Gebr. Mann Verlag, 1990); Alberto Pérez-Gómez and Louise Pelletier, *Architectural Representation and the Perspective Hinge* (Cambridge,

Mass.: MIT Press, 1997); Leonhard Schmeiser, *Die Erfindung der Zentralperspektive und die Entstehung der neuzeitlichen Wissenschaft* (Munich: W. Fink, 2002). See also Samuel Y. Edgerton, Jr., *The Heritage of Giotto's Geometry: Art and Science on the Eve of the Scientific Revolution* (Ithaca: Cornell University Press, 1991), and Martin Kemp, *Behind the Picture: Art and Evidence in the Italian Renaissance* (New Haven: Yale University Press, 1997).

2 Ernst Cassirer, *Philosophie der symbolischen Formen,* 3 vols. and index (1923–1929; repr. of 2nd ed. Darmstadt: Wissenschaftliche Buchgesellschaft, 1997); in English, *The Philosophy of Symbolic Forms,* trans. Ralph Manheim (New Haven: Yale University Press, 1953–1996). See also Cassirer's essay "Der Begriff der symbolischen Formen im Aufbau der Geisteswissenschaften" (1921–1922), repr. in Ernst Cassirer, *Wesen und Wirken des Symbolbegriffs* (Oxford: B. Cassirer, 1956).

3 Panofsky, *Perspective as Symbolic Form,* p. 41.

4 See Heinz Paetzold, *Die Realität der symbolischen Formen: Die Kulturphilosophie Ernst Cassirers im Kontext* (Darmstadt: Wissenschaftliche Buchgesellschaft, 1994).

5 Gottfried Boehm, *Studien zur Perspektivität: Philosophie und Kunst in der frühen Neuzeit* (Heidelberg: C. Winter, 1969), p. 14.

6 Cassirer, *Philosophie der symbolischen Formen,* vol. 3, pp. 165ff., 184, and 188.

7 Ibid., vol. 2, p. 105; Panofsky, *Perspective as Symbolic Form,* p. 43.

8 Panofsky, *Perspective as Symbolic Form,* pp. 29–30.

9 Cassirer, *Philosophie der symbolischen Formen,* vol. 2, pp. 106–107.

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13 Panofsky, *Perspective as Symbolic Form,* pp. 40–41.

14 Ibid., p. 71.

15 Ibid., p. 31.

16 See Boehm, *Studien zur Perspektivität.* See also Don LePan, *The Cognitive Revolution in Western Culture* (Basingstoke: Macmillan, 1989).

17 Dieter Borchmeyer, "Aufstieg und Fall der Zentralperspektive," in Gabriele Brandstetter and Gerhard Neumann, eds., *Romantische Wissenspoetik: Die Künste und die Wissenschaften um 1800* (Würzburg: Königshausen & Neumann, 2004), p. 307. Cf. Nietzsche, *The Genealogy of Morals* III: 12. For more on Nietzsche see Volker Gerhardt, "Die Perspektive des Perspektivismus," *Nietzsche-Studien* 18 (1989): 260–281.

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20 Werner Hofmann, *Die Moderne im Rückspiegel: Hauptwege der Kunstgeschichte* (Munich: Beck, 1998).

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22 Merleau-Ponty's essay, first published under the title "Le langage indirect et les voix du silence," in *Les temps modernes* 7 and 8 (1951–1952), appears in English translation as "Indirect Language and the Voices of Silence," in *The Merleau-Ponty Aesthetics Reader: Philosophy and Painting,* ed. Galen A. Johnson and Michael B. Smith (Evanston: Northwestern University Press, 1993), quote on p. 86.

23 Ibid., p. 87.

24 See Peter Greenaway, *Prospero's Books: A Film of Shakespeare's* The Tempest (London: Chatto & Windus, 1991), and Belting, *Art History after Modernism,* pp. 188–191.

25 Peter Greenaway, *The Baby of Mâcon* (Paris: Dis Voir, 1994).

26 Ecke Bonk, "Der Raum der Malerei ist erleuchtet vom Flimmern der Bildschirme," *Wolkenkratzer* (1985), especially p. 5.

27 Elkins, *The Poetics of Perspective,* pp. 50–51 and figure 2; Robert D. Romanyshyn, *Technology as Symptom and Dream* (London: Routledge, 1989), pp. 74–75.

28 Compare Frances A. Yates, *Theatre of the World* (London: Routledge & Kegan Paul, 1969; repr. 1987).

29 In the following passage I have drawn on Myra Nan Rosenfeld, "From Bologna to Venice and Paris: The Evolution and Publication of Sebastiano Serlio's Books I and II, 'On Geometry' and 'On Perspective,'" in *The Treatise on Perspective,* ed. Lyle Massey (New Haven: Yale University Press, 203), pp. 281–321.

30 See ibid., p. 294.

31 See Lyle Massey, "Configuring Spatial Ambiguity: Picturing the Distance Point from Alberti to Anamorphosis," in Massey, *The Treatise on Perspective,* pp. 164–166.

32 Ibid., p. 166.

33 Ibid., pp. 161–167.

34 Ibid., pp. 161–166.

35 Romanyshyn, *Technology as Symptom and Dream,* pp. 32ff., 65ff., and particularly 69.

36 Gottfried Boehm pointed out a similar contradiction in the Copernican shift: "If someone while seeing also reflects on the fact that he is seeing, we may call him the master of his gaze. But at the same time he must admit his powerlessness, since no matter what he sees, he can see the limits of his perception. The world of the eye casts a shadow on itself; its visible horizon is the invisible." Boehm, "Eine kopernikanische Wende des Blicks," in *Sehsucht: Über die Veränderung der visuellen Wahrnehmung,* ed. Uta Brandes, Schriftenreihe Forum 4 (Göttingen: Steidl, 1995), pp. 25–34.

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40 Giovanni Paolo Lomazzo, *Idea del tempio della pittura* (1590; Florence: Istituto nazionale di studi sul Rinascimento, 1974), chap. 23. Compare Julius von Schlosser, *La letteratura artistica,* ed. Otto Kurz (1937; Vienna and Florence, 1967), pp. 395ff. and 402.

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42 Hans Belting, *Likeness and Presence: A History of the Image before the Era of Art,* trans. Edmund Jephcott (Chicago: University of Chicago Press, 1994).

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50 Ernst Kühnel, *Die Arabesque: Sinn und Wandlung eines Ornaments* (Wiesbaden: Dieterich'sche Verlagsbuchhandlung, 1949), pp. 3ff.

51 Necipoğlu, *The Topkapi Scroll,* pp. 111ff.

52 See, for example, the pattern books of Francesco Pelligrino and Peter Flettner, and especially Giovanni Antonio Tagliente's embroidery, in Carboni, *Venice and the Islamic World.*

53 Giovanni Battista Passeri, *Istoria della pittura in majolica* (Venice: 1758), p. 95; see Maria V. Fontana, "Islamic Influence on the Production of Ceramics in Venice and Padua," in Carboni, *Venice and the Islamic World,* pp. 280–293.

54 Carboni, *Venice and the Islamic World,* catalogue no. 60, p. 30.

55 For the leaves B. 140–141 see Friedrich Teja Bach, *Struktur und Erscheinung: Untersuchungen zu Dürers graphischer Kunst* (Berlin: Gebr. Mann, 1996), pp. 177ff., and Gerd Unverfehrt, ed., *Dürers Dinge: Einblattgraphik und Buchillustrationen aus dem Besitz der Georg-August-Universität Göttingen,* exhibition catalogue (Göttingen: Kunstsammlung der Universität Göttingen, 1997), pp. 123ff. and catalogue no. 10.

56 See Sylvia Auld, "Master Mahmud and Inlaid Metalwork in the 15th Century," in Carboni, *Venice and the Islamic World,* pp. 212–225 and catalogue no. 101.

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58 See the section on the Jesuits in the Far East in Samuel Y. Edgerton, *The Heritage of Giotto's Geometry: Art and Science on the Eve of the Scientific Revolution* (Ithaca: Cornell University Press, 1991).

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65 Li Xiang Ting, "Die moderne Kunst im Dialog der Kulturen," in *Das Erbe der Bilder,* ed. Hans Belting and Lydia Haustein (Munich: Beck, 1998), pp. 94–95.

66 Silvia Naef, *A la recherche d'une modernité arabe* (Geneva: Slatkine, 1996), pp. 299ff.

67 I am grateful for the valuable suggestions I have received from Wendy M. K. Shaw, who is preparing a publication on modernity in the Ottoman Empire and is the author of *Possessors and Possessed: Museums, Archaeology and the Visualization of History in the Late Ottoman Empire* (Berkeley: University of California Press, 2003).

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74 Patricia Fortini Brown, *Venetian Narrative Paintings in the Age of Carpaccio* (New Haven: Yale University Press, 1988), pp. 54–55.

75 Compare Barry, *Figurative Art in Medieval Islam,* p. 45, and Carboni, ed., *Venice and the Islamic World,* catalogue nos. 4 and 5.

76 Barry, *Figurative Art in Medieval Islam,* pp. 43–44.

77 Stanford Shaw, *History of the Ottoman Empire and Modern Turkey* (Cambridge: Cambridge University Press, 1976), p. 75.

78 I have adopted this term from Gülru Necipoğlu's essay "The Serial Portraits of Ottoman Sultans," which appeared in the monumental catalogue of an exhibition at the Topkapi Palace Museum in Istanbul, *The Sultan's Portrait: Picturing the House of Osman* (Istanbul: Işbank, 2000), pp. 31–32. See also the essays in the same catalogue by Julian Raby (pp. 136ff.) and Filiz Cagman (pp. 164ff.).

79 *The Sultan's Portrait,* catalogue nos. 22, 23, and 40.

2. The Taming of the Eye

1 For the best survey of this discussion see Silvia Naef, *Y a-t-il une "question d'image" en Islam?* (Paris: Téraèdre, 2004), especially pp. 66ff. and 84–85.

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3 Gülru Necipoğlu, "The Life of an Imperial Monument," in *Hagia Sophia from the Age of Justinian to the Present,* ed. Robert Mark and Ahmet S. Cakmak (Cambridge: Cambridge University Press, 1992), pp. 195ff.

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5 Ibrić, *Das Bilderverbot im Islam,* pp. 24–25 and 97.

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10 Alexander A. Vasiliev, "The Iconoclastic Edict of Caliph Yazid," *Dumbarton Oaks Papers* 9/10 (1956): 41.

11 Clément, "L'image dans le monde arabe: Interdits et possibilités," p. 19.

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15 Rudi Paret, "Textbelege zum islamischen Bilderverbot," in *Das Werk des Künstlers: Studien zu Ikonogra-*

phie und Formgeschichte: Hubert Schrade zum 60. Geburtstage (Stuttgart: Kohlhammer, 1960), pp. 36ff., especially p. 37; see also Clément, "L'image dans le monde arabe," pp. 14ff.

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17 Ibid., p. 46, citing the work *Al-Muqn'a* of the Hanbali scholar Ibn Qudamah.

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30 Ibid., p. 69. Compare also Mohammed Said Saggar, "Introduction à l'étude de l'évolution de la calligraphie arabe," in Beaugé and Clément, *L'image dans le monde arabe,* pp. 95ff.; Arthur J. Arberry, *The Koran Illuminated* (Dublin: Hodges, Figgis, 1967); and Max Weisweiler, *Der islamische Bucheinband des Mittelalters* (Wiesbaden: Harrassowitz, 1962).

31 Grabar, *The Mediation of Ornament,* pp. 69–70.

32 Ibid., pp. 72ff. and plates 7–8; see also David S. Rice, *The Unique Ibn al-Bawwab Manuscript in the Chester Beatty Library* (Dublin: Chester Beatty Library, 1955), and Michael Ryan, ed., *The Chester Beatty Library* (Dublin: Chester Beatty Library, 2001), p. 52, with illustrations.

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35 Grabar, *The Mediation of Ornament,* fig. 127.

36 Ibid., p. 113.

37 Mazhar Ş. Ipşiroğlu, *Masterpieces from the Topkapi Museum: Paintings and Miniatures* (London: Thames and Hudson, 1980), pp. 17ff. and figs. 1–7; Ernst J. Grube, "Fostat Fragments," in *Islamic Painting and the Arts of the Book,* ed. B. W. Robinson et al. (London: Faber and Faber, 1976), pp. 25ff.

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48 Michael Fried, *Absorption and Theatricality: Painting and Beholder in the Age of Diderot* (Chicago: University of Chicago Press, 1980).

49 Steffi Roettgen, *Wandmalerei der Frührenaissance in Italien,* vol. 2: *Die Blütezeit 1470–1510* (Munich: Hirmer, 1997), pp. 164ff. and plate 96. The author discusses Ghirlandaio's painting in some detail.

50 Giorgio Vasari, *The Lives of the Artists,* trans. Julia Conaway Bondanella and Peter Bondanella (Oxford: Oxford University Press, 1991), p. 219.

3. Alhazen's Measurement of Light and the Arab Invention of the Camera Obscura

1 Ricardo Moreno Castillo, *Alhacen: El Arquimedes arabe* (Madrid: Nivola, 2007).

2 Basic sources on Alhazen are Fuat Sezgin, *Geschichte des arabischen Schrifttums,* vol. 5: *Mathematik bis ca. 430 H.* (Leiden: E. J. Brill, 1974), and Alhazen, *The Optics of Ibn al-Haytham: Books I–III: On Direct Vision,* trans. and with commentary by Abdelhamid I. Sabra (London: Warburg Institute, 1989), vol. 2. Volume 1 of Sabra's translation contains the text, and vol. 2 his commentary and supplemental materials. Compare also Eilhard Wiedemann, *Aufsätze zur arabischen Wissenschaftsgeschichte,* ed. Wolfdietrich Fischer (Hildesheim: G. Olms, 1970; Eilhard Wiedemann, *Gesammelte Schriften zur arabisch-islamischen Wissenschaftsgeschichte,* ed. Dorothea Girke (Frankfurt: Institute for the History of Arab-Islamic Science at the Johann Wolfgang Goethe University, 1984); Gerhard Endress, "Mathematics and Philosophy in Medieval Islam," in *The Enterprise of Science in Islam: New Perspectives,* ed. Jan-Pieter Hogendijk and Abdelhamid I. Sabra (Cambridge, Mass.: MIT Press, 2003); and John Onians, *Neuroarthistory: From Aristotle and Pliny to Baxandall and Zeki* (New Haven: Yale University Press, 2007), pp. 38ff.

3 Saleh Beshara Omar, *Ibn al-Haytham's Optics: A Study of the Origins of Experimental Science* (Minneapolis: Bibliotheca Islamica, 1977), and Abdelhamid I. Sabra, *Optics, Astronomy, and Logic: Studies in Arabic Science and Philosophy* (Aldershot: Variorum, 1994). See also Endress, "Mathematics and Philosophy in Medieval Islam."

4 Endress, "Mathematics and Philosophy in Medieval Islam," pp. 144 and 147.

5 For more on this subject see Mustafá Nāsif, *Al-Hasan ibn al-Haytham,* 2 vols. (Cairo: Matba'at al nuri, 1942–1943); Matthias Schramm, *Ibn al-Haythams Weg zur Physik* (Wiesbaden: F. Steiner, 1963); Sezgin, *Mathematik bis ca. 430 H.,* pp. 358ff. (on Alhazen's mathematics), and Sezgin, *Geschichte des arabischen Schrifttums,* vol. 6: *Astronomie bis ca. 430 H.* (Leiden: E. J. Brill, 1978), pp. 251ff. (on Alhazen's astronomy); David C. Lindberg, *Theories of Vision from al-Kindi to Kepler* (Chicago: University of Chicago Press, 1976), pp. 58–86. See also Sabra's commentary in Alhazen, *Optics,* vol. 2, p. li; Alhazen, *Opticae thesaurus: Alhazeni Arabis libri septem,* ed. David C. Lindberg (New York: Johnson Reprint Corp., 1972), repr. of Risner's Latin translation of 1572; Roshdi Rashed, "Le Discours de la lumière d'Ibn al-Haytham," *Revue d'histoire des sciences* 21 (1968); compare Vasco Ronchi, *The Nature of Light: An Historical Survey,* trans.

V. Barocas (Cambridge, Mass.: Harvard University Press, 1970), and Roshdi Rashed, "De la géometrie du regard aux mathématiques des phénomènes lumineux," in *Filosofia e scienza classica, arabo-latina medievale e l'età moderna,* ed. Graziella Federici-Vescovini (Louvain: Fédération internationale des instituts d'études médiévales, 1999), pp. 45ff. Most recently, see Abdelhamid I. Sabra, "Ibn al-Haytham's Revolutionary Project in Optics: The Achievement and the Obstacle," in Hogendijk and Sabra, *The Enterprise of Science in Islam,* pp. 85–120, and Endress, "Mathematics and Philosophy in Medieval Islam," pp. 146ff. Compare also the works by Wiedemann listed in n. 2.

6 Alhazen, *Optics,* vol. 1, p. 6.

7 Endress, "Mathematics and Philosophy in Medieval Islam," pp. 149–150, and Sabra, "Ibn al-Haytham's Revolutionary Project," p. 90.

8 George Sarton, "The Tradition of the Optics of Ibn al-Haitham" (1938), in *Optics, Texts and Studies I–III,* ed. Fuat Sezgin et al., *Natural Sciences in Islam,* vols. 32–34 (Frankfurt: Institute for the History of Arab-Islamic Science at the Johann Wolfgang Goethe University, 2001), vol. 34, pp. 69–72, and Alhazen, *Opticae thesaurus,* ed. Lindberg.

9 See Abdelhamid Sabra's preface in Alhazen, *Optics,* vol. 2, p. xiii.

10 Robert Klein, *Form and Meaning: Essays on the Renaissance and Modern Art,* trans. Madeline Jay and Leon Wieseltier (New York: Viking, 1979), especially "Pomponius Gauricus on Perspective" and "Studies on Perspective in the Renaissance"; David Summers, *The Judgment of Science: Renaissance Naturalism and the Rise of Aesthetics* (Cambridge: Cambridge University Press, 1987).

11 The great exception is José Miguel Puerta Vilchez, *Historia del pensamiento estético arabe: Al-Andalus y la estética árabe clásica* (Madrid: Akal, 1997), pp. 686ff. (on Alhazen's optics and the origins of a theory of aesthetic perception), 689ff. (visual and aesthetic knowledge), 698ff. (theory of aesthetic perception), and 715ff. (Alhazen's terminology of art).

12 Alhazen, *Optics,* ed. Sabra, introduction to vol. 2, p. xxix.

13 Fuat Sezgin and Eckhard Neubauer, eds., *Katalog der Instrumentensammlung des Instituts für Geschichte der Arabisch-Islamischen Wissenschaften: Geographie, Nautik, Uhren, Geometrie, Optik* (Frankfurt: Institute for the History of Arab-Islamic Science at the Johann Wolfgang Goethe University, 2003).

14 Gülru Necipoğlu, *The Topkapi Scroll: Geometry and Ornament in Islamic Culture* (Santa Monica: Getty Center for the History of Art and the Humanities, 1995), p. 96.

15 Christiaan Huygens, *Œuvres complètes,* vol. 20 (The Hague: M. Nijhoff, 1940), p. 265. Compare Abdelhamid I. Sabra, "Ibn al-Haytham's Lemmas for Solving 'Alhazen's Problem,'" in *Optics, Astronomy, and Logic,* pp. 299ff.

16 Compare also Sezgin and Neubauer, *Wissenschaft und Technik im Islam,* vol. 3, p. 184; Schramm, *Ibn al-Haythams Weg zur Physik,* pp. 210ff.; and Sabra's commentary in vol. 2 of Alhazen, *Optics,* pp. xlix–lii and lxxvi.

17 Compare Sabra's commentary in Alhazen, *Optics,* vol. 2., pp. lii and 29ff.

18 Eilhard Wiedemann, "Über die erste Erwähnung der Dunkelkammer durch Ibn al-Haytham (1910)," repr. in Sezgin et al., *Natural Sciences in Islam,* vol. 33, pp. 162–163, and Joseph Würschmidt, "Zur Theorie der Camera obscura bei Ibn al-Haitham (1915), repr. in ibid., p. 253.

19 Omar, *Ibn al-Haytham's Optics,* pp. 83 and 89.

20 See Sabra's commentary in Alhazen, *Optics,* vol 2., p. 24.

21 Sabra, "Ibn al-Haytham's Revolutionary Project," pp. 105–106.

22 See Gérard Simon, *Le regard, l'être et l'apparence dans l'optique de l'antiquité* (Paris: Éditions du Seuil, 1988), and Roshdi Rashed, "De la géometrie du regard," pp. 45ff.

23 See Françoise Frontisi-Ducroux and Jean-Pierre Vernant, *Dans l'œil du miroir* (Paris: O. Jacob, 1997), p. 138.

24 Ibid., p. 145.

25 Seneca, *Naturales quaetiones,* vol. 1, trans. Thomas H. Corcoran (Cambridge, Mass.: Harvard University Press, 1971), I.5.1–4.

26 Frontisi-Ducroux and Vernant, *Dans l'œil du miroir,* p. 145.
27 Ibid., p. 146.
28 Plato, *Timaeus; Critias; Cleitophon; Menexenus; Epistles,* trans. R. G. Bury (Cambridge, Mass.: Harvard University Press, 1952), 45b–45c.
29 Lindberg, *Theories of Vision,* pp. 3–6.
30 The boaster was Abu Uthman (died 869). See Eilhard Wiedemann, "Zur Physik bei den Arabern" (1910), repr. in Sezgin and Neubauer, *Wissenschaft und Technik im Islam,* vol. 3, pp. 31ff.
31 Frontisi-Ducroux and Vernant, *Dans l'œil du miroir,* p. 243.
32 Ibid., p. 184. Euripides, *Medea,* trans. David Kovacs (Cambridge, Mass.: Harvard University Press, 1994), lines 1159–1162.
33 Frontisi-Ducroux and Vernant, *Dans l'œil du miroir,* p. 143.
34 Alhazen, quoted in Omar, *Ibn al-Haytham's Optics,* p. 99.
35 A. I. Sabra, "Explanation of Optical Reflection and Refraction: Ibn al-Haytham, Descartes, Newton," *Optics, Astronomy and Logic: Studies in Arabic Science and Philosophy* (Aldershot: Variorum, 1994), p. 551.
36 Rashed, "Le Discours de la lumière d'Ibn al-Haytham," on Alhazen's philosophy of light, pp. 213ff.: "Les lignes droites sont des lignes virtuelles et non réelles."
37 Ibid., p. 214, and Alhazen, *Optics,* vol. 2, p. 9 (commentary by Sabra).
38 Rashed, "Le Discours de la lumière d'Ibn al-Haytham," pp. 213ff.
39 For what follows, see ibid., pp. 205, 207, 216, and 220.
40 Omar, *Ibn al-Haytham's Optics,* p. 67.
41 Lindberg, *Theories of Vision,* p. 73.
42 A. I. Sabra, "The Physical and the Mathematical in Ibn al-Haytham's Theory of Light and Vision," in *Optics, Astronomy and Logic,* pp. 2ff.
43 Omar discusses these experiments in detail; see *Ibn al-Haytham's Optics,* pp. 78ff.
44 Sezgin and Neubauer, *Wissenschaft und Technik im Islam,* vol. 3, p. 172.
45 Ibid., p. 178 with illustrations.
46 Ibid., p. 180, and Omar, *Ibn al-Haytham's Optics,* pp. 71–72 with fig. 7.
47 See the extended commentary by Sabra in Alhazen, *Optics,* vol. 2, pp. 68–70, and also A. I. Sabra, "Form in Ibn al-Haytham's Theory of Vision," in *Optics, Astronomy and Logic,* p. 116.
48 A. I. Sabra, "Psychology versus Mathematics: Ptolemy and Alhazen on the Moon Illusion," in *Optics, Astronomy and Logic,* p. 233.
49 Puerta Vilchez, *Historia del pensamiento estético arabe,* pp. 699ff., and *Encylopaedia of Islam,* new ed., vol. 6 (Leiden: Brill, 1991), pp. 346ff. I am grateful to Silvia Horsch at the Center for Literary Research in Berlin for her advice.
50 The passage in Book VII of Alhazen's *Optics* from which this quotation is taken appears for the first time in translation in Sabra, "Psychology versus Mathematics," p. 237.
51 Ibid., p. 239.
52 See also Puerta Vilchez, *Historia del pensamiento estético arabe,* p. 701. Vilchez's fundamental study of Alhazen in the context of Arab aesthetics pursues a different goal. He cites mostly from Nāsif's 1942 Arabic edition of *The Optics* (mentioned above in n. 5).
53 Cited according to ibid., p. 694.
54 See Sabra's commentary in Alhazen, *Optics,* vol. 2, pp. liv and 62–67; Puerta Vilchez, *Historia del pensamiento estético arabe,* pp. 691–692; and Necipoğlu, *Topkapi Scroll,* pp. 201ff.
55 Puerta Vilchez, *Historia del pensamiento estético arabe,* pp. 715–716.
56 Ibid., p. 719.
57 Sabra, "Ibn al-Haytham's Revolutionary Project," p. 96.
58 This applies above all to Puerta Vilchez and Necipoğlu, despite their commendable efforts to assess for the first time Alhazen's understanding of art and his study of the role of imagination.
59 Necipoğlu, *Topkapi Scroll,* p. 104.

60 Oleg Grabar, *The Shape of the Holy: Early Islamic Jerusalem* (Princeton: Princeton University Press, 1996), pp. 57ff. and 71ff, with figs. 38–49.

61 Necipoğlu, *Topkapi Scroll,* p. 92.

62 Ibid., pp. 134–137.

63 Grabar, *Mediation of Ornament,* pp. 25ff and 144.

64 Necipoğlu, *Topkapi Scroll,* p. 103.

65 Valérie Gonzalez, "Réflexions esthétiques sur l'approche de l'image dans l'art islamique," in *L'image dans le monde arabe,* ed. Gilbert Beaugé and Jean-François Clément (Paris: CNRS, 1995), pp. 69ff., especially 74–75.

66 Necipoğlu, *Topkapi Scroll,* pp. 118–119, and Oleg Grabar, *The Alhambra* (Cambridge, Mass.: Harvard University Press, 1978), p. 145.

67 Lecture by José Montesinos at the Academia Europa conference held in Toledo, Spain, September 2007.

68 Oleg Grabar, *The Formation of Islamic Art,* rev. ed. (New Haven: Yale University Press, 1987), p. 187.

69 Jules Bourgoin, *Les elements de l'art arabe* (Paris: Firmin-Didot, 1879); designs repr. in Bourgoin, *Arabic Geometric Pattern and Design* (Mineola, N.Y.: Dover, 1974).

70 E. and M. Mikovicky, "Arabic Geometrical Patterns: A Treasury for Crystallographic Teaching," *Neues Jahrbuch für Mineralogie* (1977): 56–68.

71 Peter Lu and Paul Steinhardt, "Decagonal and Quasi-Crystalline Tilings in Medieval Islamic Architecture," *Science* 315 (February 2007): 1106–1110. Compare also John Bohannon, "Quasi-Crystal Conundrum Opens a Tiling Can of Worms," ibid., 1066.

72 Ibid., p. 1106.

73 Necipoğlu, *Topkapi Scroll.*

74 See Sarah Kofman, *Camera obscura: De l'idéolgie* (Paris: Galilée, 1973); Svetlana Alpers, *The Art of Describing: Dutch Art in the Seventeenth Century* (Chicago: University of Chicago Press, 1983), pp. 26–71 on Kepler's model of the eye; Jonathan Crary, *Techniques of the Observer: On Vision and Modernity in the Nineteenth Century* (Cambridge, Mass.: MIT Press, 1990), on the camera obscura and its subject; Peter Bexte, *Der blinde Seher: Wahrnehmung von Wahrnehmung in der Kunst des 17. Jahrhunderts* (Dresden: Verlag der Kunst, 1999), chap. 4, pp. 81–109; Ulrike Hick, *Geschichte der optischen Medien* (Munich: Fink, 1999), pp. 47–80, on the camera obscura; Leonhard Schmeiser, *Die Erfindung der Zentralperspektive und die Entstehung der neuzeitlichen Wissenschaft* (Munich: Fink, 2002), pp. 146–191; Larry J. Schaaf, "Camera obscura und Camera lucida," in *Ich sehe was, was du nicht siehst: Sehmaschinen und Bilderwelten,* ed. Bodo von Dewitz and Werner Nekes (Göttingen: Steidl, 2002), pp. 48ff. Compare also Lindberg, *Theories of Vision from Al-kindi to Kepler,* pp. 178–208, on Kepler.

75 Johannes Kepler, *Optics: Paralipomena to Witelo & Optical Part of Astronomy,* trans. William H. Donahue (Santa Fe: Green Lion Press, 2000), chap. 5, sec. 2, pp. 180–181. See also Lindberg, *Theories of Vision from Al-kindi to Kepler,* pp. 178–208.

76 Kepler, "Tychonis Hyperaspistes," *Gesammelte Werke* 8, ed. Franz Hammer (Munich: Beck, 1963), 19; Erwin Panofsky, "Die Perspektive als symbolische Form," *Deuschsprachige Aufsätze,* ed. Karen Michels and Martin Warnke (Berlin: Akademie Verlag, 1998), p. 675n11.

77 Cf. Lindberg, *Theories of Vision from Al-kindi to Kepler,* pp. 178–208.

78 René Descartes, "*Optics,*" in *Discourse on Method, Optics, Geometry, and Meteorology,* trans. Paul J. Olscamp, rev. ed. (Indianapolis: Hackett, 2001), p. 67.

79 Ibid., p. 90.

80 Ibid., p. 68.

81 Ibid., p. 108.

82 Ibid., p. 89

83 Ibid., p. 90.

84 Ibid., pp. 91–93.

85 Ibid., p. 97.

86 Ibid., p. 90.
87 Ibid., p. 91.
88 Compare Hick, *Geschichte der optischen Medien,* pp. 81ff. and 115ff.
89 Ibid., pp. 43–44.
90 Logan Pearsall Smith, *The Life and Letters of Sir Henry Wotton* (Oxford: Clarendon Press, 1907), vol. 2, pp. 205–206.

4. Perception as Knowledge

1 I have based this passage on the work of Katherine Tachau, *Vision and Certitude in the Age of Ockham: Optics, Epistemology and the Foundations of Semantics, 1250–1345* (Leiden: Brill, 1988), pp. 3–27 and 113–155. Compare also Graziella Federici Vescovini, *Studi sulla prospettiva medievale* (Turin: Giappichelli, 1965).
2 Roger Bacon, *Roger Bacon's Philosophy of Nature: A Critical Edition with English Translation, Introduction and Notes of* De multiplication specierum *and* De speculis comburentibus, ed. David C. Lindberg (South Bend, Ind.: St. Augustine's Press, 1998), p. 200.
3 Ibid., pp. 4–5.
4 Tachau, *Vision and Certitude,* p. 8.
5 Ibid., p. 14.
6 Ibid., p. 16.
7 Stuart Clark, *Vanities of the Eye: Sight in Early Modern European Culture* (Oxford: Oxford University Press, 2007), pp. 15–16.
8 Michael Camille, "Before the Gaze: The Internal Senses and Late Medieval Practices of Seeing," in *Visuality Before and Beyond the Renaissance,* ed. Robert S. Nelson (Cambridge: Cambridge University Press, 2000), pp. 210–211.
9 Tachau, *Vision and Certitude,* pp. 113–135.
10 Ibid., p. 131.
11 Ibid.
12 David Summers, *The Judgment of Sense: Renaissance Naturalism and the Rise of Aesthetics* (Cambridge: Cambridge University Press, 1987), pp. 35–36, with reference to *Opus majus,* part 5.1.
13 Hans Belting, "Das Bild als Text: Wandmalerei und Literatur im Zeitalter Dantes," in *Malerei und Stadtkultur in der Dantezeit,* ed. Hans Belting und Dieter Blume (Munich: Hirmer, 1989), pp. 32ff., on doctrine and personal experience.
14 Christian Trottmann discusses this topic in detail in *La vision béatifique: Des disputes scholastiques à sa definition par Benoît XII* (Rome: École française de Rome, 1995).
15 Belting, "Das Bild als Text," p. 52, and Joachim Poeschke, *Wandmalerei der Giottozeit in Italien 1280–1400* (Munich: Hirmer, 2003), p. 338 and plate 203. The Strozzi Chapel was decorated in 1356 by Nardo di Cione.
16 Belting, "Das Bild als Text," pp. 34–35.
17 A selection of literature on the subject: Erwin Panofsky, *Perspective as Symbolic Form,* trans. Christopher Wood (New York: Zone Books, 1991); John White, *The Birth and Rebirth of Pictorial Space* (London: Faber and Faber, 1957; 3rd ed. Cambridge, Mass.: Belknap Press of Harvard University Press, 1987), pp. 57ff. and 72ff.; Wolfgang Kemp, *Die Räume der Maler: Zur Bilderzählung seit Giotto* (Munich: Beck, 1996), pp. 16ff. and 26ff.; Martin Kemp, *The Science of Art: Optical Themes in Western Art* (New Haven: Yale University Press, 1990), pp. 9ff.; Christoph Feldtkeller, *Der architektonische Raum, eine Fiktion: Annäherung an eine funktionale Betrachtung* (Braunschweig: Vieweg, 1989); Samuel Y. Edgerton, *The Heritage of Giotto's Geometry: Art and Science on the Eve of the Scientific Revolution* (Ithaca: Cornell University Press, 1991); Paul Hills, "Giotto and the Students of Optics," in Andrew Ladis, ed., *The Arena Chapel and*

the Genius of Giotto: Padua (New York: Garland, 1998), pp. 310–317; Anne Mueller von der Hagen, *Die Darstellungsweise Giottos mit ihren konstitutiven Momenten* (Braunschweig: Books on Demand GmbH, 2001); Charles Parkhurst, "Roger Bacon on Color: Sources, Theories and Influence," in *The Verbal and the Visual: Essays in Honor of William Sebastian Heckscher,* ed. Karl-Ludwig Selig and Elizabeth Sears (New York: 1990), pp. 192–193.

18 Michael V. Schwarz and Pia Theis, *Giottus Pictor,* vol. 1 (Vienna: Böhlau, 2004), p. 387, and Gerhard Wolf, *Schleier und Spiegel: Traditionen des Christusbildes und die Bildkonzepte der Renaissance* (Munich: Fink, 2002), p. 304, fig. 1.

19 Compare White, *The Birth and Rebirth of Pictorial Space;* Edgerton, *The Heritage of Giotto's Geometry;* and Kemp, *The Science of Art.*

20 Filippo Villani, *De origine civitatis Florentiae,* cited in Schwarz and Theis, *Giottus Pictor,* vol. 1, p. 287.

21 Kemp, *Die Räume der Maler,* pp. 22 and 26ff.

22 Belting, "Das Bild als Text," pp. 54–55; for detailed commentary on the text see Friedrich Marx, ed., *Incerti auctoris de ratione dicendi ad C. Herennium Libri IV* (Leipzig: B.G. Teubner, 1894), pp. 278ff (book III).

23 Giuseppe Basile, ed., *Giotto: The Frescoes of the Scrovegni Chapel in Padua* (Milan: 2002; distributed by Rizzoli International), pp. 21ff. and figs. 378, 379; see also Poeschke, *Wandmalerei der Giottozeit,* plate 98.

24 White, *Birth and Rebirth of Pictorial Space,* p. 72. See also plates 129–141 in Poeschke, *Wandmalerei der Giottozeit.*

25 Poeschke, *Wandmalerei der Giottozeit,* pp. 250ff. and plates 148 and 149, and Andrew Ladis, *Taddeo Gaddi: Critical Reappraisal and Catalogue Raisonné* (Columbia: University of Missouri Press, 1982), pp. 88ff.

26 Belting, "Das Bild als Text," pp. 56–57, with further literature; illustration in Poeschke, *Wandmalerei der Giottozeit,* plate 64. A dissertation on this work is in preparation by Raphaèle Preisinger.

27 Henk van Os, *Sienese Altarpieces, 1215–1460,* vol. 1, trans. Michael Hoyle (Groningen: Bouma's, 1984), pp. 79–80 and fig. 91; Chiara Frugoni, *Pietro and Ambrogio Lorenzetti* (Florence: Scala, 1988), pp. 14–15 and fig. 15; Kemp, *The Science of Art,* pp. 10–11 and fig. 5.

28 Kemp, *The Science of Art,* p. 11.

29 The research undertaken by Graziella Federici Vescovini has guaranteed Biagio a secure place in the history of science, but it has received too little attention outside the Italian literature on the subject. See the following works: G. Federici Vescovini, "Le questioni di 'perspectiva' di Biagio Pelacani da Parma," *Rinascimento* 12 (1961): 163–206 (commentary) and 207–243 (text); *Studi sulla prospettiva medievale* (Turin: Giappichelli, 1965); introduction to Biagio Pelacani, *Le quaestiones de anima,* ed. G. Federici Vescovini (Florence: L. S. Olschki, 1974); "Biagio Pelacani a Firenze, Alhazen e la prospettiva del Brunelleschi," in *Filippo Brunelleschi: La sua opera e il suo tempo,* Convegno internazionale di studi Filippo Brunelleschi (Florence: Centro Di, 1980), pp. 333–348; G. Federici Vescovini and Francesco Barocelli, eds., *Filosofia, scienza e astrologia nel trecento europeo: Biagio Pelacani Parmense* (Padua: Il Poligrafo, 1992), in particular her essay "Biagio Pelacani," pp. 39–52; G. Federici Vescovini, ed., *Filosofia e scienza classica, arabo-latina medievale e l'età moderna* (Louvain: Fédération internationale des instituts d'études médiévales, 1999); "Il vocabulario scientifico de *De Pictura,*" in *L'idée de la nature chez Leon Battista Alberti, 1404–1472,* ed. Michel Paoli (Paris: Champion, 1999), pp. 213ff. See also Francesco Barocelli, "Per Biagio Pelacani," in Federici Vescovini and Barocelli, *Filosofia, scienza e astrologia,* pp. 21–36, and Valeria Sorge, "L'influenza di Alhazen sulla dottrina della vision in Biagio Pelacani di Parma," in ibid., pp. 113–127.

30 Biagio Pelacani, *Quaestiones phyiscorum* and *Quaestiones de anima,* cited according to Federici Vescovini, "Biagio Pelacani a Firenze," p. 345.

31 Ibid., p. 334 and n. 14.

32 Ibid., pp. 336–337 and n. 33.

33 See Federici Vescovini's edition of *Quaestiones perspectivae* in *Rinascimento* 12 (1961): 243.

34 Ibid., p. 226.

35 Ibid., p. 232.
36 From *Quaestiones perspectivae,* cited in Federici Vescovini, *Studi sulla prospettiva medievale,* p. 260n65.
37 Cited according to Federici Vescovini, "Biagio Pelacani a Firenze," p. 338.
38 *Quaestiones physicorum,* cited according to ibid., p. 331.
39 Ibid., pp. 340–341; see also Barocelli, "Per Biagio Pelacani."
40 Barocelli, "Per Biagio Pelacani," p. 37n30.
41 Federici Vescovini, *Studi sulla prospettiva medievale,* pp. 231–232 with citations.
42 *Questiones de generatione,* cited according to Federici Vescovini, "Biagio Pelacani a Firenze," p. 338.
43 *Quaestinoes methauorum,* cited according to Federici Vescovini, *Studi sulla prospettiva medievale,* pp. 245–246 with n. 14.
44 Ibid., p. 246 with n. 14.
45 *Quaestiones perspectivae,* see Federici Vescovini, *Studi sulla prospettiva medievale,* p. 257nn51–53.
46 Lorenzo Ghiberti, *Der dritte Kommentar Lorenzo Ghibertis: Naturwissenschaften und Medizin in der Kunsttheorie der Frührenaissance,* ed. and trans. Klaus Bergdolt (Weinheim: VCH, 1988).
47 Ibid., pp. 22.1 and 40.6.
48 Ibid., pp. 14.6 and 142.1.
49 Ibid., pp. 24–28 and 16.12.
50 Richard Krautheimer and Trude Krautheimer-Hess, *Lorenzo Ghiberti* (Princeton: Princeton University Press, 1970), pp. 248–253.
51 The *cassamenti* he mentions should probably not be understood as frames but rather as architectural backdrops, even though this applies to only a small number of the panels. For more on this subject see Krautheimer and Krautheimer-Hess, *Ghiberti,* and in confirmation, John R. Spencer, *Filarete's Treatise on Architecture,* vol. 1 (New Haven: Yale University Press, 1965), p. 302 and fol. 77.
52 Krautheimer and Krautheimer-Hess, *Ghiberti,* pp. 249–250, plate 94, and fig. 7. Compare Kemp, *The Science of Art,* pp. 24–25.
53 Krautheimer and Krautheimer-Hess, *Ghiberti,* pp. 9–10 and plate 136; see also John Pope-Hennessy, *The Portrait in the Renaissance* (New York: Bollingen Foundation, 1966), pp. 70–71 with illustration.
54 Julius von Schlosser, *Leben und Meinungen des Florentiner Bildners Lorenzo Ghiberti* (Basel: Holbein-Verlag, 1941), p. 215.
55 Piero della Francesca, *De prospectiva pingendi,* ed. Giusta Nicco Fasola (Florence: Sansone, 1942), pp. 64–65. See also Kemp, *The Science of Art,* p. 27; and two essays in Lyle Massey, ed., *The Treatise on Perspective: Published and Unpublished* (New Haven: Yale University Press, 2003): Margaret Daly Davis, "Architecture and Perspective: Perspective, Vitruvius, and the Reconstruction of Ancient Architecture: The Role of Piero della Francesca's *De prospectiva pingendi,*" and especially J. V. Field, "Piero della Francesca's Perspective Treatise."
56 Piero della Francesca, *De prospectiva pingendi,* pp. 64–65.
57 Ibid., pp. 75–77.
58 Introduction to the edition of *De prospectiva pingendi* translated by Jean-Pierre Le Goff: *De la perspective en peinture* (Paris: In Media Res, 1998), p. 39.
59 Piero della Francesca, *De prospectiva pingendi,* p. 128.
60 John White, *The Birth and Rebirth of Pictorial Space,* 3rd ed. (Cambridge, Mass.: Harvard University Press, 1987), p. 128.
61 Kemp, *The Science of Art,* p. 27.
62. Piero della Francesca, *De la perspective en peinture,* p. 41n10.
63 Piero della Francesca, *De prospectiva pingendi,* p. 100.
64 Ibid., p. 65n3.
65 Jay Alan Levenson, "Jacopo de' Barbari and Northern Art of the Early Sixteenth Century," Ph.D. thesis, New York University (1978), pp. 99–100 and catalogue no. 52; Nick Mackinnon, "The Portrait of Fra

Luca Pacioli," in *The Mathematical Gazette* 77 (1993): 130ff.; Duilo Contin, "Incontro con Luca Pacioli," in Contin, ed., *Gli scacchi di Luca Pacioli* (San Sepulcro: Aboca Edizioni, 2007), pp. 71–72.

66 Piero della Francesca, *De prospectiva pingendi,* p. 66.

67 Ghiberti, *Der dritte Kommentar,* p. 4.

68 Enrico Narducci, "Intorno ad una traduzione italiana del trattao d'ottica d'Alhazen" (1871), in *Optics: Texts and Studies,* vol. III, ed. Fuat Sezgin et al., *Natural Sciences in Islam,* vol. 34 (Frankfurt: Institute for the History of Arab-Islamic Science at the Johann Wolfgang Goethe University, 2001), pp. 1–51.

69 Ghiberti, *Der dritte Kommentar,* pp. 6 and 8.

70 Pliny the Elder, *The Natural History,* Book 35, chap. 36.

71 Lorenzo Ghiberti, *Denkwürdigkeiten (I Commentarii),* ed. Julius Schlosser (Berlin: J. Bard, 1912). See also Ghiberti, *Der dritte Kommentar,* p. xxxiii, and *I commentarii,* ed. Lorenzo Bartoli (Florence: Giunti, 1998), pp. 73–74. For more on Pliny's text see Sabine Mainberger, "Zu Plinius' Erzählung vom Paragone der Linien," in *Im Agon der Künste: Paragonales Denken, ästhetische Praxis und die Diversität der Sinne,* ed. Hannah Baader et al. (Munich: Fink, 2007), pp. 19ff.

72 Panofsky, *Perspective as Symbolic Form,* pp. 37–38.

73 Ghiberti, *Der dritte Kommentar,* pp. xc–xci. Compare also Ghiberti, *I commentarii* pp. 95–96.

74 Ghiberti, *Der dritte Kommentar,* pp. xciv–xcv; quotation at 564.18–566.237.

75 Myra Nan Rosenfeld, "From Bologna to Venice and Paris: The Evolution and Publication of Sebastiano Serlio's Books I and II, 'On Geometry' and 'On Perspective,' for Architects," in Massey, *The Treatise on Perspective,* pp. 292–293 and n. 74.

5. Brunelleschi Measures the Gaze

1 For more on Brunelleschi see *Filippo Brunelleschi, la sua opera e il suo tempo: Relazioni presentate al convegno internazionale di studi tenutosi a Firenze nel 1977,* 2 vols. (Florence: Centro Di, 1980); Heinrich Klotz, *Filippo Brunelleschi: The Early Works and the Medieval Tradition,* trans. Hugh Keith (New York: Rizzoli, 1990); Uta Schedler, *Filippo Brunelleschi: Synthese von Antike und Mittelalter in der Renaissance* (Petersberg, Germany: Michael Imhof, 2004).

2 Various editions of this work exist: *On Painting and On Sculpture: The Latin Texts,* ed. and trans. Cecil Grayson (London: Phaidon, 1972); *Das Standbild: Die Malkunst: Grundlagen der Malerei,* ed. Oskar Bätschmann and Christoph Schäublin (Darmstadt: Wissenschaftliche Buchgesellschaft, 2000); *De la peinture,* ed. and trans. Jean-Louis Schefer (Paris: Éditions Macula, 1999). For more on Alberti see Anthony Grafton, *Leon Battista Alberti: Master Builder of the Italian Renaissance* (Cambridge, Mass.: Harvard University Press, 2002); Mark Jarzombek, *On Leon Baptista Alberti: His Literary and Aesthetic Theories* (Cambridge, Mass.: MIT Press, 1989); Hanno-Walter Kruft, *A History of Architectural Theory: From Vitruvius to the Present,* trans. Ronald Taylor, Elsie Callander, and Antony Wood (New York: Princeton Architectural Press, 1994), pp. 41–50.

3 See the introduction by Howard Saalman in Antonio Manetti, *Life of Brunelleschi,* ed. Saalman, trans. Catherine Enggass (University Park: Pennsylvania State University Press, 1970), p. 18. See also Antonio Manetti, *Vita di Filippo Brunelleschi,* ed. Deomenico de Robertis (Milan: Il Polifilo, 1976).

4 Manetti, *Life of Brunelleschi,* p. 42. What Enggass translates as "rationally" is *con ragione* in the original Italian, a phrase that can also be rendered in English as "systematically" or "with a system."

5 Giorgio Vasari, *Le vite,* ed. Gaetano Milanesi (Florence: Sansoni, 1906), vol. 2, pp. 383–384.

6 John Pope-Hennessy, *The Portrait in the Renaissance* (New York: Bollingen Foundation, 1966), p. 8 and figs. 7 and 8.

7 Gerhard Wolf, *Schleier und Spiegel: Traditionen des Christusbildes und die Bildkonzepte der Renaissance*

(Munich: Fink, 2002), p. 3 and fig. 1. See also Michael V. Schwarz and Pia Theis, *Giottus pictor,* vol. 1 (Vienna: Böhlau, 2004), pp. 387–388.

8 John Pope-Hennessy, *Paolo Uccello* (New York: Phaidon, 1969), pp. 57–58 and plates 107–112. Compare also Andreas Beyer, *Das Porträt in der Malerei* (Munich: Hirmer, 2002), p. 61.

9 Manetti, *Life of Brunelleschi,* pp. 42–44.

10 Quoted according to Hubert Damisch, *The Origin of Perspective,* trans. John Goodman (Cambridge, Mass.: MIT Press, 1994), p. 63.

11 Brian Rotman, *Signifying Nothing: The Semiotics of Zero* (Stanford: Stanford University Press, 1987), pp. 17–19.

12 Compare the editions mentioned in n. 2 above.

13 Martin Kemp, *The Science of Art: Optical Themes in Western Art* (New Haven: Yale University Press, 1990), p. 23.

14 Compare Lyle Massey, "Configuring Spatial Ambiguity: Picturing the Distance Point," in *The Treatise on Perspective: Published and Unpublished,* ed. Massey (New Haven: Yale University Press, 2003), pp. 161ff.

15 Samuel Y. Edgerton, *The Renaissance Rediscovery of Linear Perspective* (New York: Basic Books, 1975), p. 134.

16 See Erwin Panofsky, *Perspective as Symbolic Form,* trans. Christopher Wood (New York: Zone Books, 1991), pp. 27–36; also Martin Kemp, *The Science of Art* and *Behind the Picture: Art and Evidence in the Italian Renaissance* (New Haven: Yale University Press, 1997).

17 Manetti, *Life of Brunelleschi,* pp. 52–54.

18 For more on the Baptistery see Wolfgang Braunfels, *Mittelalterliche Stadtbaukunst in der Toskana* (Berlin: Gebr. Mann, 1953), pp. 143ff., and the extensive discussion in Schedler, *Filippo Brunelleschi,* pp. 111ff.

19 Rudolf Wittkower, *Architectural Principles in the Age of Humanism,* 4th ed. (New York: St. Martin's Press, 1988).

20 Heinrich Klotz's *Filippo Brunelleschi* is the exception to this rule, but Klotz tends to take the medieval tradition as his point of departure.

21 Kruft, *A History of Architectural Theory.* See also Leon Battista Alberti, *On the Art of Building in Ten Books,* trans. Joseph Rykwert, Neil Leach, and Robert Tavenor (Cambridge, Mass.: MIT Press, 1988), and Veronica Biermann, *Ornamentum: Studien zum Traktat* "De re aedificatoria" *des Leon Battista Alberti* (Hildesheim: Olms, 1997).

22 Preface to Alberti, *On the Art of Building,* p. 1.

23 Alberti, *On the Art of Building,* pp. 154–155.

24 Alberti, *Delineation of the City of Rome (Descriptio urbis Romae),* ed. Mario Carpo and Francesco Furlan, trans. Peter Hicks, Medieval and Renaissance Texts and Studies 335 (Tempe: Arizona Center for Medieval and Renaissance Studies, 2007), p. 97.

25 Alberti, *On the Art of Building,* pp. 5, 7.

26 Ibid., p. 34.

27 Ibid., p. 317.

28 This quotation comes from a paragraph contained only in the copies of Alberti in Lucca and St. Gallen; see Bätschmann and Schäublin, *Das Standbild: Die Malkunst: Grundlagen der Malerei,* pp. 367–368.

29 Christoph Luitpold Frommel, "Sulla nascità del disegno architettonico," in *Il Rinascimento da Brunelleschi a Michelangelo: La rappresentazione dell'architettura,* ed. Henry A. Millon and Vittorio Magnago Lampugnani, exhibition catalogue (Venice: Palazzo Grassi, 1994), pp. 101ff.

30 Myra Nan Rosenfeld, "From Bologna to Venice and Paris: The Evolution and Publication of Sebastiano Serlio's Books I and II, 'On Geometry' and 'On Perspective' for Architects," in Massey, *The Treatise on Perspective,* p. 292.

31 Klotz, *Filippo Brunelleschi,* pp. 129ff.

32 Horst Woldemar Janson, *The Sculpture of Donatello* (Princeton: Princeton University Press, 1957), vol. 1, plates 187–231; vol. 2, pp. 132–140.

33 From the enormous body of literature on the subject I will mention only Eve Borsook, *The Mural Painters of Tuscany: From Cimabue to Andrea del Sarto,* 2nd ed. (New York: Oxford University Press, 1980), pp. 58–63 with plates 73–75; Florian Huber, *Das Trinitätsfresko von Masaccio und Filippo Brunelleschi in Santa Maria Novella zu Florenz* (Munich: Tuduv, 1990); and Leonhard Schmeiser, *Die Erfindung der Zentralperspektive und die Entstehung der neuzeitlichen Wissenschaft* (Munich: Fink, 2002).

34 See the evidence provided by Schmeiser, *Die Erfindung der Zentralperspektive,* p. 28.

35 Norman Bryson, *Vision and Painting: The Logic of the Gaze* (New Haven: Yale University Press, 1983), p. 110.

36 Gabriele Morolli, "Ortodossie albertiniane nella 'brunelleschiana' Cappella dei Cardini a Pescia," *Atti del convegno su Andrea Cavalcanti detto il "Buggiano"* (Bologna: Editografica, 1980), pp. 47–60; Francesco Gurriere, "La Cappella Cardini di Pescia," *Bolletino d'arte* 31/32 (1985): 97–124; Massimo Bulgarelli, "La Cappella Cardini a Pescia," in *All'ombra delle volte: Architettura del Quattrocentro a Firenze e Venezia,* ed. Massimo Bulgarelli and Matteo Ceriana (Milan: Electa, 1996), pp. 13–103. I am grateful to Annette Hoffmann in Florence for her help in searching out this literature.

37 Marilyn Aronberg Lavin, *Piero della Francesca: The Flagellation* (Chicago: University of Chicago Press, 1990); Carlo Ginzburg, *Indagini su Piero* (Turin: G. Einaudi, 1981); Carlo Bertelli, *Piero della Francesca,* trans. Edward Farrelly (New Haven: Yale University Press, 1992), pp. 115–130; Birgit Laskowski, *Piero della Francesca* (Cologne: Könemann, 1996), p. 81. For more about Piero's treatise on perspective see J. V. Field, "Piero della Francesca's Perspective Treatise," in Massey, *The Treatise on Perspective,* pp. 63–77.

38 Bernd Roeck, *Mörder, Maler und Mäzene: Piero della Francesca's "Geisselung": Eine kunsthistorische Kriminalgeschichte* (Munich: Beck, 2006).

39 Ulrike Hick, *Geschichte der optischen Medien* (Munich: Fink, 1999), pp. 115ff. Compare also Horst Beinlich, ed., *Magie des Wissens: Athanasius Kircher, 1602–1680* (Dettelbach: J. H. Röll, 2002).

40 For more on the history of the stage see Manfred Brauneck, *Die Welt als Bühne: Geschichte des europäischen Theaters* (Stuttgart: Metzler, 1993), vol. 1, especially pp. 406ff. For more on theaters in the time of humanism and the Renaissance, see Günter Schöne, *Die Entwicklung der Perspektivbühne von Serlio bis Galli-Bibiena* (Leipzig: Voss, 1933); Götz Pochat, *Theater und bildende Kunst im Mittelalter und in der Renaissance in Italien* (Graz: Akademische Druck- u. Verlagsanstalt, 1990); and most recently Ulrike Hass, *Das Drama des Sehens: Auge, Blick und Bühnen form* (Munich: Fink, 2005). On the invention of scenery and the baroque stage see Brauneck, *Die Welt als Bühne,* vol. 1, pp. 131ff. and 23ff.; on Pozzo, pp. 28–29.

41 The children would look like adults at a greater distance. Brauneck, *Die Welt als Bühne,* vol. 1, p. 356.

42 Candida Höfer, *Opéra de Paris,* with text by Gérard Mortier (Munich: Schirmer Mosel, 2006), p. 23. I am grateful to the artist for permission to reproduce the photograph.

43 Dagobert Frey, "Zuschauer und Bühne: Eine Untersuchung des Realitätsproblems des Schauspiels," in *Kunstwissenschaftliche Grundfragen: Prolegomena zu einer Kunstphilosophie,* ed. Frey (Vienna: Rohrer, 1946; repr. Darmstadt: Wissenschaftliche Buchgesellschaft, 1992), pp. 151–223; see pp. 176ff. on theater in the Middle Ages, p. 180 on Julius Caesar Scaliger.

44 Brauneck, *Die Welt als Bühne,* vol. 1, pp. 354ff., and Pochat, *Theater und bildende Kunst,* pp. 86ff. For more on *sacra rappresentazione* see Richard Trexler, *Public Life in Renaissance Florence* (New York: Academic Press, 1980), pp. 374ff.

45 Pochat, *Theater und bildende Kunst,* pp. 95ff.

46 For more on Botticini's painting see Martin Davies, *The Earlier Italian Schools,* vol. 2, 2nd ed. (London: National Gallery, 1961), pp. 118ff.

47 Hass, *Das Drama des Sehens,* p. 178n93 and p. 188.

48 Ibid., pp. 172 and 178–179.

49 Brauneck, *Die Welt als Bühne,* vol. 1, pp. 460–461, and Pochat, *Theater und bildende Kunst,* p. 297.

50 Pochat, *Theater und bildende Kunst,* pp. 188 and 197.

51 Ibid., pp. 184–185. Compare also Brauneck, *Die Welt als Bühne,* vol. 1, pp. 462ff.

52 Hass, *Das Drama des Sehens,* pp. 189–196.

53 Sebastiano Serlio, *Regale generali di architettura* (Venice, 1537–1551), vol. 2, pp. 44 and 48ff., with "Trattato sopra la scena" and reference to the genres of tragedy and comedy.

54 Compare Pochat, *Theater und bildende Kunst,* p. 303 and fig. 217.

55 For an example of this dualism see the discussion of Piero's *Polyptych of St. Anthony* in Laskowski, *Piero della Francesca,* p. 97.

56 Sebastiano Serlio, *On Architecture,* ed. Vaughan Hart and Peter Hicks, 2 vols. (New Haven: Yale University Press, 1996); Sabine Frommel, *Sebastiano Serlio, Architect,* trans. Peter Spring (Milan: Electa Architecture; London: distributed by Phaidon, 2003); Rosenfeld, "From Bologna to Venice and Paris," pp. 281–321. For more on the theater in Serlio's work see Brauneck, *Die Welt als Bühne,* vol. 1, pp. 462ff., and also Pochat, *Theater und bildende Kunst,* pp. 306ff. and 313ff. on types of stages.

57 Ekkehard Mai, ed., *Paris Bordone: Motiv und Bedeutung: Architektur und Perspektive im Bild* (Cologne: 1993), pp. 17ff. and 26ff. on Serlio, whose remarks on stage design appeared in print at about the same time that Bordone painted his *Bathsheba.* Compare also the important text by David Rosand, "Theater and Structure in the Art of Paolo Veronese," in *Painting in Cinquecento Venice: Titian, Veronese, Tintoretto,* ed. Rosand (New Haven: Yale University Press, 1982), pp. 145ff.

58 Allardyce Nicoll, *Stuart Masques and the Renaissance Stage* (New York: Harcourt Brace, 1938), pp. 58–59.

59 Mauro Zanchi, *Bilder der Bibel von Lorenzo Lotto: Das Ikonostase in der Basilika zu Bergamo* (Bergamo: 2006), pp. 54–55.

60 Brauneck, *Die Welt als Bühne,* vol. 2.

61 See Felix Burda-Stengel, *Andrea Pozzo und die Videokunst: Neue Überlegungen um barocken Illusionismus* (Berlin: Gebr. Mann, 2001), pp. 41ff., especially p. 46, for Pozzo's treatise, and pp. 87ff. for more on Sant'Ignazio.

62 Christine Buci-Glucksmann, *La folie du voir: Une esthéstique du virtuel* (Paris: Galilée, 2002), p. 99.

63 François Hédelin, abbé d'Aubignac, *La pratique du théâtre,* ed. Hélène Baby (Paris: H. Champion, 2001), pp. 77ff., 85ff., and 355ff. Compare also Jean Rousset, *L'intérieur et l'extérieur: Essais sur la poésie et sur le théâtre au XVIIe siècle* (Paris: Corti, 1968), pp. 169ff.

64 Hick, *Geschichte der optischen Medien,* p. 109.

65 Claude Nicolas Ledoux, *L'architecture considerée sous le rapport de l'art, des mœurs et de la legislation* (1804; repr. Paris: de Nobele, 1962).

66 Michel Foucault, *Discipline and Punish: The Birth of the Prison,* trans. Alan Sheridan (New York: Vintage Books, 1995), pp. 195ff.

67 The most informative studies can be found in Richard Krautheimer, "Le tavole di Urbino, Berlino e Baltimora riesaminate," in Millon and Lampugnani, *Il Rinascimento,* pp. 233–257; Hartmut Biermann, "War L. B. Alberti in Urbino?" *Zeitschrift für Kunstgeschichte* 65 (2002): 493–521; Bernd Roeck and Andreas Tönnesmann, *Die Nase Italiens: Federico da Montefeltro, Herzog von Urbino* (Berlin: 2005); see also Damisch, *The Origin of Perspective,* pp. 289–290. On the intarsia in Urbino see James Elkins, *The Poetics of Perspective* (Ithaca: Cornell University Press, 1994), pp. 128ff.

68 Alessandro Gambuti, *L'architettura dei pittori nel Quattrocento Italiano* (Florence: Alinea, 1994).

69 For more on what follows, compare Roeck and Tönnesmann, *Die Nase Italiens,* pp. 129ff. and 171ff. with suggestions for further reading.

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